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OPPORTUNITIES AND RISKS PRESENTED TO AGRICULTURE BY LINEAR DEVELOPMENTS

PROJECT NO. 271315

UNDER

CANADA, BRITISH COLUMBIA SUBSIDIARY AGREEMENT ON

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EXECUTIVE SUMMARY

In September of 1982 TERA Environmental Consultants Ltd. received a contract under the Agriculture and Rural Development Subsidiary Agreement, Research Program to investigate the Opportunities and Risks Presented to Agriculture by Linear Developments.

Inventory

An inventory was prepared of existing and proposed linear projects in B.C. The location of existing and proposed electrical transmission lines with operating voltages over 230 kV and oil and gas transmission pipelines was drafted onto an updated map of Agricultural Land Reserve (ALR) of B.C.

Proposed electrical transmission lines would increase the area covered by rights-of-way by 70% to about 67,000 ha. The area of electrical transmission rights-of-way within the ALR would increase by 40% to about 20,000 ha or about 0.4% of the total ALR. Key regions where agricultural development may be increased as a result of development of electrical transmission lines are the Cariboo, Omineca, and Peace Regions. Key regions where negative impacts on agriculture could be caused by linear development are the Mainland, (Lower Fraser Valley), Vancouver Island (southeastern section) and the Okanagan (east side of Okanagan Lake).

Proposed pipelines would increase the area covered by pipeline rights-of-way by 37% to about 12,000 ha. The area of pipeline right-of-way within the ALR would increase by 30% to about 4,000 ha or about 0.08% of the total ALR if all proposed projects proceed. Extensive pipeline development is expected in the Peace and Vancouver Island Regions, and could have significant impacts on the agriculture of these regions. Only about 0.006% of the ALR has been permanently alienated by electrical and pipeline stations. Linear projects do not occupy a large portion of the agricultural land base in B.C. but they form part of the increasing pattern of non-farm development that competes for land resources with agriculture.

CASE STUDIES

Two case studies were undertaken to gain a practical appreciation of the interaction of linear developments and agriculture, one in the lower Fraser Valley and one in the Fraser Plateau.

Interference with automated irrigation equipment was found to be the most costly impact of electrical transmission on agriculture. The presence of electrical transmission towers in a field led to several major negative impacts including: land loss of uncropped areas, time loss in avoiding towers, yield loss due to increased compaction around towers, yield loss due to increased weed populations, increased costs such as extra seed and fertilizer around towers, and possible damage of farm equipment from collisions with towers. Electrostatic and electromagnetic effects were significant concerns in dairy areas due to the possible contributory effect of transmission lines to tingle voltages and shocks. Other effects such as noise and radio interference were only inconveniences.

The largest positive impact of transmission lines was noted in the Crown range areas of the Fraser Plateau. In these areas the right-of-way can save ranchers $6,400 in clearing costs and added grazing of 5 AUM per year per kilometre of cleared right-of-way. This positive effect was felt to be sufficient to more than balance the negative effects on rangeland.

Pipelines were found to have less interaction with agriculture than electrical transmission lines. The most serious impact is continuing yield loss on fine textured soils along the trenchlines. Such losses can amount to $500. per kilometre per year for corn silage.

Highways and railways were a major source of land loss in the Lower Fraser Valley Study. A single track railway removed 0.3 ha from cultivation per kilometre.

Common corridors were found to be beneficial in both case studies.

POLICY REVIEW

Since the 1950's a complex system of Federal and Provincial governmental controls and industrial self-regulation has evolved to address concerns raised by linear projects. The rationale for this regulation is that optimum decisions on project location and design can be made only if all benefits and costs of a project are taken into account.

ELECTRICAL TRANSMISSION

Alienation of agricultural land by electrical transmission totals approximately 200 ha and is not a threat to the agricultural industry. Several impacts of electrical transmission lines do cause significant costs to farmers. Since most of these costs can be greatly reduced by available mitigation measures, impact management policies are advisable.

The Energy Project Review Process was found to provide a basis for complete and efficient identification of impacts to agriculture. Three areas of general improvement can be identified. The first area involves electrical transmission lines that were not reviewed under the EPRP because they were either too small or constructed before the process was in place. The second area which could be improved concerns the strengthening of agricultural input into the review process. The third area deals with information flow; the EPRP is new and many of the details of the process are known only to a few people.

PIPELINES

While few existing or proposed electrical transmission lines are regulated by the National Energy Board (NEB), most of the existing and proposed pipelines in B.C. are actively regulated by the NEB. The B.C. Utilities Commission Act may create an overlapping jurisdiction between the Federal and Provincial governments. The strengths of both the provincial and federal regulatory systems should be adopted by all agencies involved with environmental review. Specifically, stronger protection for owners should be adopted by the B.C. Utilities Commission and the federal NEB should utilize the expertise of provincial field staff for assessing agricultural and range concerns.

Construction phase impacts of pipelines are well documented and compensation measures appear adequate. There are two long term effects of pipelines on agriculture: the most significant impact was the continuing loss of yields immediately over pipeline trenches. This problem probably only occurs in fine textured soils or where contractors did not follow approved procedures. Further research on the extent of this problem and ways to combat it are recommended. Another effect pipeline rights-of-way have on farming operations is through the restriction on building development on the right-of-way. For this reason, new pipeline rights-of-way should avoid existing intensive agricultural developments.

RAILROADS AND HIGHWAYS

Railroads and highways cause significant impacts on agriculture due to the area of land they occupy and additional costs due to land fractionation. In practice, the existing review processes are often equivalent to self-regulation by a linear developer as they do not involve basic approval by any third party or Certificate of Public Convenience by an independent authority.

Recommendations for highways include a procedure for land owners to request minor route realignments for proposed highways and the preparation and use of an Environmental Procedures Manual for roads similar to those used for pipelines.

In general, the study concluded that while linear developments do not constitute a threat to agriculture, they can have impacts that extend well beyond the right-of-way. While most of the impacts are negative, positive impacts were significant in some areas. There are many techniques which can be employed to greatly lessen the negative impacts. These recommendations are made to improve impact management by both regulatory bodies and linear operators.

ACKNOWLEDGEMENTS

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The authors would like to acknowledge the important contribution made by the Project Management Committee: The Committee was chaired by Mr. Harvey Sasaki of the Farmland Resources Branch, Ministry of Agriculture and Food. Other committee members were Mr. Ted Horbulyk of the ARDA Branch, Ministry of Agriculture and Food, Mr. Jim Plotnikoff, Mr. Kabel Atwall and Mr. Kirk Miller of the B.C. Agricultural Land Commission and Mr. Earl Jenson of the Range Management Branch, Ministry of Forests.

The authors appreciate the high level of cooperation received from all those contacted during the study. In particular, contributions of Westcoast Transmission Co. Ltd., B.C. Hydro and Power Authority, the Ministry of Transportation and Highways, The Federal Environmental Review Office and the National Energy Board greatly added to this study.

The responsibility for the report as written and all conclusions reached herein is the consultant's alone, and does not necessarily reflect the opinions of those who assisted during the course of this investigation and the federal and provincial governments which funded the study.

S1.0 INTRODUCTION

In September of 1982 TERA Environmental Consultants Ltd. received a contract under the Agriculture and Rural Development Subsidiary Agreement, Research Program to investigate the Opportunities and Risks Presented to Agriculture by Linear Developments. The need for this project was created by the unprecedented number of large scale transmission line and pipeline projects that have been proposed for British Columbia. It was known that a variety of positive and negative agricultural impacts can be attributed to large scale linear projects. However, in order to optimize the effects of these projects, further information was required. The project had the following objectives:

To provide an overview of the type, size, length and location of existing and proposed linear developments in the province and the areal extent of their effects on agriculture.

To identify the potential impacts and effects presented to agriculture by linear developments in British Columbia.

To prepare an annotated bibliography on the opportunities and risks presented by linear developments.

To recommend changes in existing policies, guidelines and regulations, which would lead to greater realization of potential opportunities and mitigation of potential risks.

The study was divided into three phases. Section 2.0 of the main volume reports on the findings of the inventory phase. Section 3.0 reports on two case studies that were conducted. Government policies, regulations, and guidelines are reviewed in Section 4.0 which includes recommendations for changes to the current regulatory structure. The study findings are presented in three volumes consisting of a Summary, Main Volume and Appendix volume.

The study team was led by Michael Goldstein, P. Ag. Other team members were Helmut Urhahn, Janet Waterman, James LaMorte and Barbara Element.

In general, the study concluded that while linear developments do not constitute a threat to agriculture, they can have impacts that extend well beyond the right-of-way. While most of the impacts are negative, positive impacts were significant in many areas. There are many techniques which can be employed to greatly lessen the negative impacts. New projects are regulated by a complex system of controls which are designed to insure that environmental and land use concerns, which are external to the prime objectives of linear project developers, are considered. Impact management is seen as the best available approach for improving the relationship between agriculture and linear projects. Recommendations based on the findings of the study are presented in Section 4. These recommendations are intended to improve impact management by both regulatory bodies and linear operators.

S2.0 INVENTORY

S2.1 Existing and Proposed Linear Develpments

An inventory was prepared of existing and proposed linear projects in B.C. The location of existing and proposed electrical transmission lines with operating voltages over 230 kV and oil and gas transmission pipelines was drafted onto an updated map of Agricultural Land Reserves of B.C. This map is at a scale of 1:1,000,000 and accompanies the main volume of the report. Information on the location of linear projects was gathered from interviews with linear project operators and published maps. The areas within linear project rights-of-way and occupied by electrical substations and pipeline compressor and pumping stations were calculated for each of the 8 Agricultural Reporting Regions in British Columbia. The following assumptions were made in making these calculations:

Linear project type	Width of right-of-way
Electrical transmission lines	
300-500 kV	64m
230-300 kV	42m
Pipelines	
transmission	15m
gathering	10m

No information was readily available on the size of substations and pipeline stations. Based on a limited number of stations, an average size of 10 ha was assumed for all major linear development stations. While the methodology used to develop the inventory was subject to error, the author feels that the data generated in this report is accurate to one significant figure. Highway and railway development is summarized after a regional review of electrical transmission lines and pipelines.

British Columbia

The Canadian Agricultural Economic Research Council estimates 23% of B.C. economic activity is directly or indirectly generated by agriculture.[1] With wholesale sales of $2.6 billion, agriculture ranks third behind forestry and mining. Table S2-1 shows the total length of existing and proposed electrical transmission lines and pipelines in B.C. and within the Agricultural Land Reserve.

Table S2-1 shows that the system of electrical transmission lines could increase by 75% in the next twenty years. The increase in electrical transmission right-of-way within the ALR is expected to be only 40%. The major reason for this difference is that major hydroelectric generation projects are planned for remote areas where agricultural land is scarce and agricultural reserves have not been established. Key regions where agricultural development may be increased as a result of development of electrical transmission lines are the Cariboo, Omineca, and Peace Regions. Key regions where negative impacts on agriculture could be caused by linear development are the Mainland, (Lower Fraser Valley), Vancouver Island (southeastern section) and the Okanagan (east side of Okanagan Lake).

Pipelines show a smaller potential increase than electrical transmission lines, about 37%. The increase in pipeline right-of-way within the ALR would be about 30%. Pipeline rights-of-way are narrower than electrical transmission lines. Since pipelines are completely buried, they have more impact on soil compaction but much less impact on field operations than electrical lines. In general, pipeline development will have less of an effect both positively and negatively than electrical transmission line development. Extensive pipeline development is expected in the Peace and Vancouver Island Regions, and could have significant impacts on the agriculture of these regions.

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[1] Census of Agriculture for B.C., 1981, Economics Branch, Ministry of Agriculture and Food, Victoria, B.C.

Table S2-1 B.C. Linear Development Statistics

RIGHTS-OF-WAY	TOTAL km	TOTAL ha	ALR km	ALR ha
Electrical				
Existing				
500 and 360 kV	4,694[1]	30,041	1,652	10,572
230 to 287 kV	2,164	9,089	895	3,759
Proposed				
500 and 360 kV	4,062	25,996	770	4,928
230 to 287 kV	455	1,911	210	882
Total	11,375	67,037	3,527	20,141
Pipeline				
Existing (transmission)	5,325	7,987	1,795	2,692
(gathering[2])	970	970	370	370
Proposed transmission	2,114	3,165	575	862
Total	8,409	12,128	2,740	3,924
MAJOR STATIONS				
Electrical				
Existing	27	270	10	100
Proposed	5	5	3	30
Total	32	320	13	130
Pipelines				
Existing	26	260	12	120
Proposed	7	70	6	60
Total	33	330	18	180

TOTALS	TOTAL	ALR
Right-of-way	79,165ha	24,065ha
Total land area	89,310,362ha	4,700,230ha
% Right-of-way	0.09%	0.51%
Stations	650ha	310ha
% in Stations	0.0007%	0.006%

[1] Data generated by author, see section 2.1.1 for methodology

[2] Gathering lines registered by the National Energy Board

Substations on electrical transmission lines, compressor stations on gas pipelines and pumping stations on oil pipelines take up only a small fraction of the land as compared with their associated right-of-way; less than 1%. This area is significant because these stations are single use, and, unlike the right-of-way, preclude agricultural development. Another factor is that these stations generally occur more frequently within the ALR than rights-of-way. Approximately 30% of rights-of-way are within the ALR, while half of the major stations are within the ALR. Several factors will tend to maintain this pattern. In general, stations require flat land with good access. A major factor in determining the location of future linear projects and stations is the location of existing facilities. New linear projects are viewed as additions to the systems rather than independent projects. Normally transmission systems of a single type are operated by a single company in B.C.

At present, rights-of-way for electrical transmission lines and pipelines occupy about 0.4% of the ALR. If proposed rights-of-way are added, about 0.5% of the ALR will be occupied by linear projects. Only about 0.006% of the ALR has been permanently alienated by electrical and pipeline stations. Linear projects are not a great threat to agriculture in B.C. individually, but they form part of the increasing pattern of non-farm development that competes for land resources with agriculture.

The Kootenay Region

One additional 500kV and several 230kV transmission lines and one additional gas transmission line are proposed for the Kootenay Region. The 500kV transmission line is to be completed in 1985 and connects the Cranbrook Substation to the Alberta border via Crowsnest Pass. There are several proposed 230kV lines, the longest of which follows the Rocky Mountain Trench north from Cranbrook.

The proposed pipeline follows the existing Alberta Natural Gas Pipeline between Corbin and Kingsgate. Both of these projects will cross the important agricultural area southeast of Cranbrook.

Existing and proposed electrical and pipeline rights-of-way occupy 2598 ha within the Agricultural Land Reserve or about 0.8% of the ALR in the Region.

Electrical transmission lines have and will continue to supply an important source of grazing land to the region by clearing and revegetating forested areas. At the same time, electrical transmission towers can greatly disrupt field operation in the limited land areas capable of grain and vegetable production. Careful routing of proposed transmission lines could avoid most of the cultivatable land and increase grazing capacities on rangeland. Lack of weed control along rights-of-way in grazing areas is a significant problem which affects rangeland productivity. Pipelines will not greatly affect agriculture in the Kootenay Region.

The Okanagan Region

Existing and proposed rights-of-way occupy 1510 ha within the Agricultural Land Reserve or 0.5% of the ALR in the region. There is a 230 kV transmission line and highway proposed for the east side of Okanagan Lake. This corridor is now used for a gas pipeline and electrical transmission line. Use of shared or adjacent rights-of-way may not be advisable in this corridor but a common corridor study of linear developments on the east side of Okanagan Lake would be of value. Both existing and proposed electrical transmission lines may interfere with orchards and irrigation systems in the region. Research into the cultivation of dwarf tree fruit varieties and irrigation design under high voltage transmission lines would benefit agriculture in the region. Greater use of large automated irrigation systems on forage land is also anticipated which would result in conflicts with transmission lines. Lack of weed control along rights-of-way is also a significant problem. Pipelines are not a major agricultural issue in the Okanagan Region.

The Island Region

The rapid development of Vancouver Island has lead to construction of the Cheekeye to Dunsmuir electrical transmission line which has been connected to Victoria by two 500 kV transmission lines. It also seems likely that a gas pipeline will be built to the Island and a gas distribution system will be developed between Campbell River and Victoria. These gas pipelines may be routed extensively through the ALR on the Island. A major highway development is proposed from Nanaimo to Campbell River. In the more distant future, the Homathko hydroelectric project will probably affect the more remote and undeveloped areas of the Region. This project could encourage agricultural development if access and Crown land is made available. Existing and proposed rights-of-way occupy 1,510 ha in the Agricultural Land Reserve or about 0.7% of the ALR in the region.

Studies should be conducted into the advisability of shared or adjacent rights-of-way on the east side of Vancouver Island in order to minimize land losses. Some specialized land uses, such as seed cone orchards, which are found on Vancouver Island may be well suited to electrical transmission rights-of-way. Other uses, such as forest transplant nurseries, may be hard to develop on electrical transmission rights-of-way. Interference with irrigation systems, land loss, and restrictions on intensive developments such as greenhouses on electrical transmission rights-of-way could be major negative impacts.

The Mainland Region

The major negative impacts resulting from electrical transmission lines include land loss and interference with field operations. Pipelines will result in some loss. Unfortunately these negative impacts are highly concentrated in the Lower Fraser Valley. The valley bottom now contains 3 major transmission lines, 3 major pipelines, 3 railways, and 2 major highways. Unfortunately, each linear project operator has acted independently from the others, resulting in a maze of projects. Since most of these rights-of-way are established, most of the opportunities for mitigating their impacts have passed. Although few projects have been planned for the Lower Fraser Valley, the pressure to utilize this wide (20 km) natural corridor through the Coast Mountains will increase with the size of Vancouver. Existing and proposed rights-of-way occupy about 3,071ha within the Agricultural Land Reserve or about 1.95% of the ALR in the region.

Proposals in this Region include the Westcoast Transmission Vancouver Island natural gas pipeline project which poses neither opportunities nor risks to agriculture and the competing B.C. Hydro Gas pipeline which will traverse high capability agricultural lands in Delta. The entire length or about 75 ha of right-of-way of the proposed B.C. Hydro Vancouver Island natural gas pipeline is in the ALR.

The Thompson Region

The Thompson Region has several concentrations of linear projects. The Kelly Lake Substation connects 10 electrical transmission lines and three more 500 kV lines are proposed. Four major pipelines cross the region and a proposed gas pipeline to Vancouver Island passes through the region. A new highway between Hope and Kamloops is also proposed. In total, 4,133 ha within the Agricultural Land Reserve or about 0.75% of the ALR in the region is occupied by linear developments. A significant portion of this and the remaining 8,000 ha of right-of-way is on land that is used for cattle grazing.

Several important agricultural issues are associated with the extensive rights-of-way in the Region. In grazing areas, existing and proposed electrical transmission rights-of-way can provide increased grazing opportunities by revegetating and/or clearing right-of-ways. However, in areas of cultivation and forage production, increased use of automated irrigation systems will increase the conflict between agriculture and electrical transmission towers. Weed control along transmission lines is also a significant issue. The effects of the proposed electrical transmission lines entering and leaving Kelly Lake substation and the proposed Hope-Kamloops highway, will largely be determined by which routes are chosen.

The Cariboo Region

In most of the province, agriculture and linear developments share restricted valley bottoms. In the Cariboo they share an extensive plateau. Several large electrical transmission projects are planned for the region. An additional 500 kV line will join the 3 existing lines between Prince George and Kelly Lake. Power from northern hydroelectric projects and power from the proposed Homathko hydroelectric project in the central Cariboo will be routed south through the Cariboo. These projects could double the areas of rights-of-way in the Cariboo. Most of these rights-of-way could provide benefits to agriculture. Interference with irrigation, land loss, and soil disruption in key low elevation areas could cause major negative impacts. The proposed pipeline would not greatly affect agriculture. Existing and proposed rights-of-way occupy 5,690ha within the Agricultural Land Reserve or about 0.62 of the ALR in the Region.

Key aspects of the linear project/agricultural interaction will be the location of a major substation west of the Fraser River, and routing of the proposed Northern Transmission and Homathko electrical transmission lines away from low elevation land with a high capability for irrigated agriculture.

The Omineca Region

Several major linear developments are planned for the Omineca Region. The largest of these is the Stikine-Iskut transmission project. The proposed lines would connect hydroelectric generation stations on the Stikine and Iskut Rivers to Terrace and Telkwa (Smithers). The second major project is a gas pipeline proposed by Dome Petroleum and Westcoast Transmission to link Alberta Gas to a Liquefied Natural Gas (LNG) terminal north of Prince Rupert. Existing and proposed linear projects would cover 4,480 ha or 0.6% of the ALR in the Omineca District.

The development of resources presents opportunities for agricultural expansion in the Omineca Region. The additional electrical transmission line along Highway 16 and the southern section of the Stikine-Iskut project will clear forested land. In areas with existing beef ranches, the new right-of-way has the potential to add over 1000 AUM (Animal Unit Months) of grazing capacity in the region. In more remote areas, new ranches may be developed to take advantage of the cleared land and improved access. In particular, such opportunities may exist along the Cranberry, Kitwanga, Kitsumkalum and Nass Rivers.

The LNG pipeline proposal could increase the potential for agricultural development of the Great Beaver Lake-Fort St. James area. The growth in population associated with resource development would increase the demand for locally produced agricultural products. Negative impacts on agriculture from linear development will occur where these projects follow narrow constricted agricultural valley bottoms. The Bulkley and Lower Skeena are examples of potential problem areas.

The Peace Region

Oil and gas development has been the key resource development until the recent development of northeast coal mines. The region is unique in that pipeline rights-of-way far exceed electrical transmission rights-of-way in land area. Another unique feature is the gathering systems centred around Dawson Creek and Fort St. John. These pipelines are smaller in diameter than the transmission pipelines and are listed as a separate item in the main volume. Most of the proposed linear projects for the Peace Region are gas pipelines. The largest of these are the Foothills Alaska Highway Gas Pipeline and the Dome/Westcoast Gas Pipeline. This picture would change greatly if B.C. Hydro's Liard Hydroelectric Project is undertaken. The project would involve almost 15,000 ha of transmission right-of-way either in the Rocky Mountain Trench or in the Foothills or both.

The direct effect of pipelines on agricultural production in the Peace River Area has not been well researched. Considering the magnitude of the interaction, studies which measure the effect of pipeline on yield and the impact of drilling platforms are required. If the Liard Hydroelectric project proceeds, possibilities for development of new agricultural land will be opened up by transmission lines, but negative impacts, such as interference with cropping practices, would also occur. The net effect would be positive in the short run if agricultural developments follow right-of-way construction but without careful route selection, transmission lines could impose significant negative impacts in the future.

S2.2 Overview of Impacts of Linear Developments on Agriculture

Linear developments such as highways, railways, transmission lines, and pipelines have positive or negative impacts on the natural environment they cross, the people who earn their living and make their life within this environment, and the people who live a distance from the development but are still connected to the development by economic or social ties. These impacts can be direct, such as the removal of arable land from production or indirect, such as the growth of market population for agricultural products. Some impacts occur only during construction or during the first few years after construction of a linear project. Others have a long term effect that might not be felt until long after a project is completed.

The following tables review the basic interactions between the type of linear development and different intensities of agriculture. Individual impacts are listed in these tables according to stage of linear development activity. Normal mitigation measures are listed for each impact. An X is used to indicate whether the impact is restricted to the right-of-way and to indicate the duration of the impact. Four intensities of agriculture are then listed: cultivated fields, improved pasture, rangeland, and potential farmland. For each of these intensities one of the following ratings is given for each impact: N - negative impact, NS - no significant impact or P - positive impact.

TABLE S2-2 Electrical Transmission Lines/Agriculture Interactions

Activity	Impact	Mitigation	Location Right-of-way On	Location Right-of-way Off	Term Long	Term Short	Cultivated Fields	Improved Pasture	Range Land	Potential Farmland
ACCESS	improved farm access,	road upgrading,	–	x	x	–	NS[2]	NS	P	P
	increased traffic,	fence & gates	x	x	x	–	N	N	N	N
	cut fences,	refencing	–	x	–	x	N	N	N	NS
	soil compaction	ripping	–	x	x	–	N	N	N	N
CLEARING	saved expense, weed spread	reseeding & spraying	x	–	x	–	NS	NS	P	P
CONSTRUCTION	interference with field operations,	timing & notice	–	x	x	x	N	N	N	NS
	interference with cattle,	timing, notice, fences	x	x	–	x	N	N	NS	NS
	soil compaction,	ripping & timing	–	x	–	x	NS	NS	N	NS
	loss of crop	compensation[1]	x	–	x	–	N	N	N	N
TOWER STRUCTURES	land loss,	tower type	x	–	x	–	N	N	N	NS
	time loss,	route modification	x	–	x	–	N	N	NS	N
	loss of yield,	tower position	x	–	x	–	N	N	NS	NS
	increased expense,	and orientation	x	–	x	–	N	N	NS	NS
	interference with irrigation		x	–	x	–	N	N	NS	NS
ENERGIZING CONDUCTORS	restricted development		x	x	x	–	N	N	NS	NS
	electric shock,	route modification,	x	–	x	–	N	N	NS	NS
	accident potential	equipment design,	x	–	x	–	N	N	NS	NS
		public education	x	–	x	–	N	N	NS	NS

[1] Compensation although often necessary, may not result in any improvement of the impact and may or may not be a form of mitigation. If the compensation is not reinvested in agriculture, it would not be mitigating an agricultural impact only a socio-economic one.

[2] N – negative impact
NS– no significant impact? – unknown
P – positive impact

TABLE S2-3 Pipeline - Agriculture Interactions

Activity	Impact	Mitigation	Location Right-of-way On	Location Right-of-way Off	Term Long	Term Short	Cultivated Fields	Improved Pasture	Range Land	Potential Farmland
ACCESS	Improved access,	road upgrading	-	x	x	-	NS[1]	NS	P	NS
	Increased traffic,	fence & gates	x	x	x	-	N	N	N	N
	cut fences,	refencing	-	x	-	x	N	N	N	NS
	soil compaction	ripping	-	x	x	-	N	N	N	N
CLEARING	saved expense,	prompt reseeding	x	-	x	-	NS	NS	P	P
	weed spread		-	x	x	x	N	N	N	-
CONSTRUCTION	land loss	prompt construction	x	-	-	x	N	N	N	NS
	cut-off cattle,	bridges	-	x	-	x	N	N	NS	NS
	cut-off irrigation,	temporary pipes	-	x	-	x	N	N	NS	NS
	cut-off drainage,	prompt repair,	-	x	x	-	N	N	NS	NS
	soil compaction,	ripping & timing,	x	-	x	-	N	N	N	N
	soil improvement	de-stoning	x	-	x	-	P	P	P	P
PIPELINE	restricted development,	route modification	x	-	x	-	N	N	NS	NS
	altered drainage,	improved drainage	x	-	x	-	N-P	N-P	N-P	N-P
	potential spills,	contingency plans	-	x	x	-	N	N	N	N
	cathodic corrosion of irrigation pipe	anode field location	x	-	x	-	N	N	NS	N
AUXILIARY FACILITIES	land loss	location	x	-	x	-	N	N	NS	N
GAS TOP-OFF	cheaper energy		-	x	x	-	P	P	NS	P

[1] N - Negative Impact
P - Positive Impact
NS - No significant Impact
N-P -Positive or negative depending on location

TABLE S2-4 Highways - Agriculture Interactions

Activity	Impact	Mitigation	Location Right-of-way		Term		Cultivated Fields	Improved Pasture	Range Land	Potential Farmland
			On	Off	Long	Short				
CONSTRUCTION	land loss	route modification	x	-	x	-	N[1]	N	N	N
	weed spread	clipping & spraying	-	x	x	-	N	N	N	NS
	land fractionation	route modification, crossings	-	x	x	-	N	N	NS	NS
	Interference with irrigation	route modification	-	x	x	-	N	N	NS	NS
	interference with cattle	cattle crossings	-	x	x	-	NS	N	NS	NS
OPERATION	greater development pressure	Agricultural Land Reserves	-	x	x	-	N	N	N	N
	improved access,		-	x	x	-	P	P	NS	S
	potential spills	contingency plans	-	x	x	-	N	N	N	N

[1] N - Negative Impact
P - Positive Impact
NS - No significant Impact
N-P -Positive or negative depending on location

[2] Since roadways are not shared use areas, many of the impacts listed under transmission lines and pipelines do not exist, though land loss is much greater.

TABLE S2-5 Railway - Agriculture Interactions

Activity	Impact	Mitigation	Location Right-of-way On	Location Right-of-way Off	Term Long	Term Short	Cultivated Fields	Improved Pasture	Range Land	Potential Farmland
CONSTRUCTION	land loss	route modification	x	-	x	-	N	N	N	N
	weed spread	clipping & spraying	-	x	x	-	N	N	N	NS
	land fractionation	route modification	-	x	x	-	N	N	NS	NS
	interference with irrigation	route modification	-	x	x	-	N	N	NS	NS
	interference with cattle	cattle crossings	-	x	x	-	NS	N	N	NS
OPERATION	improved transport,		-	x	x	-	P	P	NS	NS
	potential spill	contingency plans	-	x	x	-	N	N	N	NS
AUXILIARY FACILITIES	land loss	location modification	-	x	x	-	N	N	N	N

1 N - Negative Impact
P - Positive Impact
NS - No significant Impact
N-P -Positive or negative depending on location

2 Since roadways are not shared use areas, many of tne impacts listed under transmission lines and pipelines do not exist, though land loss is much greater.

These impact ratings are only meant as a general introduction to impact analysis. The actual importance of any impact is very site and time specific. The information for these tables was obtained from the literature cited in the bibliography. (Main volume).

Common Corridors

Various types of linear development are often forced to follow routes that are roughly parallel. In areas of rugged topography, many types of linear projects may be constrained to long narrow valleys. Many linear projects end at a major city. It has long been felt that if linear projects could run adjacent to each other in such situations, rather than in separate routes, environmental impacts, including agricultural impacts, could be reduced. The theoretical aspects of this common corridor concept were studied by Ian Hayward and Associates, TERA Environmental Consultants Ltd. and McDaniels Research Ltd. in 1982. This study (Hayward, 1982) contains a list of technical and economic constraints for each project and a table indicating which type of linear projects are compatible. This study concluded that the advantages of the common corridors outweigh the disadvantages in agricultural, suburban and urban areas.

It is extremely hard to estimate the effects of a common corridor policy on agriculture in general. It may be disadvantageous if electrical lines are restricted to land that can be crossed by an oil pipeline. This situation would be detrimental to agriculture because land suitable for oil pipelines would normally have a higher agricultural capability than steeper land which an electrical transmission line could cross. Common corridors could be advantageous in other situations. The interference with irrigation systems and fractionation of land could be greatly reduced with a common corridor. In general, the cost of avoiding farmland and the technical constraints increase in the following order: electrical transmission, gas transmission, oil transmission, highways, railways. Multi-discipline common corridor studies should be conducted for several key areas, such as the Lower Fraser Valley, southeastern Vancouver Island, the Okanagan Valley and Prince George.

S2.3 Profile of Linear Project Operators

To obtain an understanding of linear developers, their plans, problems and policies toward agriculture, a series of contacts was made with the major linear project operators in B.C. The following is a list of the linear project operators active in B.C. at the present time. All of these companies were contacted.

B.C. Hydro and Power Authority
West Kootenay Power and Light Company Ltd.
Alcan Smelters and Chemicals Ltd.
Westcoast Transmission Company Ltd.
Trans Mountain Pipe Lines
Inland Natural Gas Company Ltd.
B.C. Hydro Gas Division
Foothills Pipelines Ltd.

A questionnaire was used to obtain information. In general, all of the companies were extremely cooperative. The questions were designed to be general and reflect the basic practices of the operators rather than be project or site specific. The main volume of the report contains a copy of the questionnaire and summaries of the responses to it. The appendix volume includes the lists of existing and proposed projects supplied by each of the above companies. The questionnaire included questions in each of the following areas:

1.0 Right-of-Way location criteria
2.0 Contact with farmers
3.0 Construction phase interaction with farmers
4.0 Operation and maintenance interactions with farmers
5.0 Existing and proposed projects

B.C. Hydro was aware of the ways in which their transmission facilities, both electric and gas, affected farmers and were actively attempting to develop policies to improve this relationship. West Kootenay Power and Light Co. Ltd. policies were considerably different than those of B.C. Hydro. Communications between farmers nd the utility were better in West Kootenay's case. Alcan's present operations were not felt to affect farmers. Westcoast Transmission has a farmer contact program and updates its Procedures Manual for Environmental Engineering regularly to minimize negative impacts by pipelines on farmers. The policies of other pipeline operators were similar to those of Westcoast Transmission Co. Ltd.

S2.4 Annotated Bibliography

As part of the inventory of linear projects and agriculture, an annotated bibliography was prepared. This bibliography is presented in Appendix 4. All literature cited in the annotated bibliography is listed in the bibliography at the end of the main volume. Several types of publications were reviewed but the emphasis was placed on scientific studies in which original data was generated. The annotated bibliography is divided into the following categories: Electrical Effects, Socio-economic Effects, Land Value Effects, Public Information Booklets, Other Studies.

The majority of the literature reviewed concentrated on assessing and mitigating individual impacts of electrical transmission lines and pipelines. Most studies are based on developed agricultural areas and not on ranching areas. While informative, care should be taken in applying cost estimates from these studies to British Columbia.

In particular the bibliography is a strong measurement of impacts caused by transmission towers on common cultivated crops, and effects of electrical transmission lines on land values. The largest body of literature was on the electrical effects of electric transmission lines on people, plants and animals.

Considerably less material was available on all aspects of pipelines. Many utilities publish public information booklets, but these booklets lacked sufficient detail to design irrigation under electrical transmission lines.

Unfortunately virtually no information was available on the success of government environmental regulation or utility environmental procedures. Such information is badly needed.

S3.0 PHASE II - CASE STUDIES

Two case studies were undertaken to gain a practical appreciation of the interaction of linear developments and agriculture. Two widely varying situations were chosen.

The first case study area was in the Lower Fraser Valley which consisted of a 7 kilometre long by 2 kilometre wide strip between Sumas and Chilliwack. The study area contains 2 gas pipelines in a shared right-of-way, three electrical transmission lines in one shared right-of-way, the B.C. Electric Railway, and a short section of the Trans Mountain Pipe Lines Ltd. crude oil pipeline. The predominant agricultural use of the area is dairy production. The linear developments were found to have mainly negative impacts in this area. These impacts were assessed quantitatively where possible. The effectiveness of mitigation measures was evaluated as was the potential effectiveness of mitigation measures that could have been, but were not used. The use of common corridors in this area was also evaluated.

The second case study area was located in a ranching area just north of Williams Lake. The area consisted of a 2 kilometre wide strip 10 kilometres long, following the Williston-Kelly Lake transmission lines between Williams Lake Creek and Hawks Creek. This area is used by several ranches for grazing. The electrical transmission line in this case study was found to have a net positive effect on agriculture. Several negative impacts were found and mitigation measures recommended to reduce these.

The first case study approximates a worst case situation, i.e. a prime agricultural valley adjacent to a major market through which a number of linear developments pass. The second case study represents a much more positive situation. It is an extensive plateau which would be used as improved pasture for beef production were it not for the high cost of land clearing. Taken together these two case studies represent a wide range of interaction that takes place between agriculture and linear projects. The evaluation made in these case studies is applicable to a

a wide range of the linear projects proposed for British Columbia. This summary gives general conclusions that can be drawn from these case studies. Recommendations are made in the main report for areas for further study. These include specific interactions which could not be evaluated within the scope and timing of the study and interactions which are not covered in either case study.

S3.3 Conclusions to Phase II Case Studies

The following is a short review by linear development type of the major findings of the two case studies. The applicability of the results to proposed projects is also identified.

S3.3.1 Electrical Transmission

Interference with automated irrigation equipment could be the most costly impact of electrical transmission on agriculture. When a line follows along a valley bottom such as in Case 1, the water climatic moisture demand is relatively constant along the line and soil water retention and the availability of groundwater determine the need for irrigation. Impacts are greatest on coarse-textured soils without high groundwater tables. On the Interior Plateau (Case Study #2) the majority of irrigation impacts occur along terraces along rivers.

Impacts are minimized if transmission lines avoid areas which show the greatest potential for irrigation. Impacts in the range of thousands of dollars per year per kilometre are possible. Major mitigation measures such as route modification, tower location, match-stepping and modification of irrigation systems are applicable to all areas of the province with large irrigation requirements. With these mitigation methods, the level of impacts can be reduced by several orders of magnitude. Electrical distribution lines were also found to cause serious interference with irrigation.

The presence of towers in a field led to several major negative impacts. Land loss of uncropped areas, time loss in avoiding towers, yield loss due to increased compaction around towers, yield loss due to increased weed populations, increased costs such as extra seed and fertilizer around towers, and possible damage of farm equipment from collisions with towers were all associated with the bases of transmission towers. These impacts were greatly influenced by the crops grown or the crops that could be grown. The crops which are grown are determined by the agricultural capabilities of the land, distance to markets and historical agricultural patterns. Land loss and related impacts were also influenced by tower type. The following table summarizes the case studies' findings of land loss. Other related impacts followed a similar pattern.

TABLE S3-1 Summary of Land Loss Along Electrical Transmission Lines

Case Study	Crop type	Linear structure	Land Loss m^2 per kilometre of transmission line
1	corn silage	500 kV lattice tower	345
1	corn silage	360 kV Metal H-frame tower	216
1	hay	500 kV Lattice tower	243
1	hay	360 Metal H-frame tower	60
1	pasture	500 kV Lattice tower	3
1	pasture	360 kV Metal H-frame tower	24
2	range forage	500 kV guyed V-tower	24
2	hay	500 kV guyed V-tower	300

Mitigation measures for land loss and related concerns can be grouped in order of preference:

- avoid high capability lands
- avoid areas where crops will be grown which require either frequent cultivation, large equipment or automated irrigation
- locate transmission towers along farm, field or natural boundaries
- minimize the base area of transmission tower
- change crops grown to those which are compatible with transmission lines yet which yield high returns

Unfortunately these measures were not followed in Case Study 1. The first mitigation measure was successful in greatly reducing impacts in Case Study 2.

Land loss due to substations is considerable. In both case studies, land lost to substations equalled or exceeded that lost to towers. Land loss and related impacts occur wherever towers cross cultivated land. Most of the area of the ALR crossed by electrical transmission lines would experience these types of impacts.

Three problems were noted with weed control. The most important was the nurse areas created for weeds under towers where mowers cannot reach. On intensively cropped land it cost $20. per tower per year to spray these areas. On less intensively cropped land weed populations are often left to invade surrounding areas, thus decreasing yields. The mitigation measures for this problem are similar to land loss.

The second problem is the temporary population of weeds just after construction. Farmers receive lump sum compensation for this. A major impact develops if new weed species are introduced into an area by transmission line development. Expansion of both knapweed and Canada thistle is a potential problem in northern, central and eastern B.C. along proposed routes. The third problem was continued weed population along rights-of-way in rangeland. This is a problem on all cleared pastures and does not appear to be consistently worse along rights-of-way.

Electrostatic and electromagnetic effects were significant concerns in Case Study 1 due to the possible contributory effect of tingle voltages and shocks. Other effects such as noise and radio interference were only inconveniences. In the Williams Lake case study, only inconveniences such as TV interference were reported but some uneasiness about possible biological effects was expressed.

Increased access was not viewed as a problem in the Lower Fraser Valley. In the Williams Lake area conflicts between resource users occurred throughout the study area. Although problems such as cattle gates being left open occurred along the right-of-way, it was hard to separate effects of the right-of-way from background effects. Control of access is needed in cultivated areas. In developed areas of the province such as the Lower Fraser Valley, such control is taken for granted while in remote areas access is often taken for granted. More public education on considerate use of Crown Range is needed. Some additional use of cattle guards and controlled access gates may be needed.

Soil compaction along transmission lines was noted near towers on fine-textured soils in Case Study 1 and along paths following the right-of-way on luvisolic soils in Case Study 2. Soil compaction probably resulted in lower yields in both cases. The largest positive impact of transmission lines was noted in the Crown range areas of Case Study 2. In these areas the right-of-way saved ranchers $1000./ha in clearing costs and added grazing of 0.8 AUM per hectare of cleared right-of-way. The 130m wide right-of-way thus generated an additional 10.4 AUM's per kilometre. This positive effect was felt to be sufficient to more than balance the negative effects on rangeland. For this reason, the ranchers welcome the additional line that is proposed for the right-of-way. Much of the land that is along proposed electrical transmission rights-of-way is covered by coniferous forest and has an improved agricultural capability rating of classes 4, 5, or 6. The increased grazing capacity generated from clearing of the right-of-way can result in expanded beef herds and provide ranchers with increased incomes on most of this land. Eventually agriculture may expand in the area to the extent that this rangeland is cultivated. At such time the balance of negative and positive impacts would shift. For this reason some assumptions as to the time frame of agricultural development must be made in order to predict the future impacts of a proposed electrical transmission line. Such predictions are necessary when designing mitigation measures.

S3.3.2 Pipelines

Pipelines were found to have less interaction with agriculture than electrical transmission lines. The most serious impact is continuing yield loss on fine textured soils along the trenchlines. Such losses can amount to $500. per kilometre per year for corn silage. Drainlines could lower this loss in some situations. The cost of installing drainlines may be greater adjacent to pipelines. Since the impacts of pipelines are closely related to fine soils, the Peace Region with its fine-textured soils and large number of existing and proposed pipelines may be an area to study in greater detail. Vancouver Island and the Lower Fraser Valley may also be areas of concern.

S3.3.3 Railways

The B.C. Hydro Railway was a major source of land loss in Case Study 1. This single track railway removed 3500m^2 from cultivation per kilometre. Double tracking of the CN mainline is therefore a concern to agriculture as the line traverses many agricultural areas. Since railways can increase land fractionation, the location of new railways should insure that economically sized fields are maintained and crossings for farm animals and equipment are provided where required.

S3.3.4 Roadways

Inspection of aerial photographs of the Sumas Valley show roadways as the largest source of land loss in the area. In case study 2 the Cariboo Highway resulted in loss of agricultural land rated as class 2 with irrigation. In either case, roads were needed to give farmers access to areas. Major highways alienate more agricultural land and rangeland than is necessary to provide access. Roads can also result in land fractionation. In case study 2 the Cariboo Highway resulted in direct land loss and increased costs but not additional land loss due to land fractionation. Agricultural impacts should be considered when planning new roads and widening or realigning existing ones.

S3.3.5 Common Corridor Concerns

The relative locations of linear developments were found to affect their interaction with agriculture. Farmland could be divided into areas too small to be farmed efficiently. Placement of linear developments together could substantially minimize such impacts. Another situation where common corridors were an advantage was in case study 2. By using a wide right-of-way for several electrical lines, cattle management problems were reduced. Grouped rights-of-way also decreased the cost of weed control measures. Interference with irrigation can be lessened in some situations by common corridors. Another advantage to common corridors is the increased efficiency of managing a farm crossed by several rights-of-way if only one route is used. In valleys such as the Sumas Valley where several linear developments are forced to follow similar routes, the use of a common corridor should always be investigated.

Common corridor studies may also be needed on the east side of Vancouver Island and the east side of the Okanagan Valley.

Although common corridors were found to be beneficial in both case studies, this is not always the case. If a common corridor policy forces an electrical transmission line to follow the level terrain necessary for oil pipelines, both agricultural impacts on transmission costs could drastically increase.

S4.0 PHASE III - POLICY REVIEW

S4.1 Introduction

The number and extent of linear projects in British Columbia have rapidly expanded over the last 30 years. Appreciation of how these projects interact with other land users and the natural environment has also grown over the years. Since the 1950's a complex system of governmental controls and industrial self-regulation has evolved to address concerns raised by linear projects. The rationale for this regulation is that optimum decisions on project location and design can be made only if all benefits and costs of a project are taken into account.

S4.2 Electrical Transmission

S4.2.1 Current Regulation

Federal Regulation

There is currently little federal environmental regulation of electrical transmission projects in B.C. and only one regulatory agency directly responsible for reviewing proposals: The National Energy Board (NEB). The NEB was established in 1959 by the National Energy Board Act and was given the authority to review energy projects. The NEB regulates only those individual power lines leading to or crossing an international border.

Provincial Regulation

Provincial regulation of electrical transmission projects falls into two categories. The first includes the environmental review processes. The second category comprises special purpose legislation.

There are three basic environmental review processes followed in British Columbia. Large energy projects deemed to be significant for the province are regulated by the Utilities Commission Act through the Energy

Project Review Process.(EPRP) Projects of moderate size that cross regional boundaries can be reviewed by the Provincial Government under the Guidelines for Linear Development. Smaller projects of mostly regional significance were reviewed by Regional Resource Management Committees before these committees were discontinued.

In addition to the three basic review mechanisms discussed above, the provincial government implements a number of special acts that address the preservation of the agriculture industry. Special purpose acts such as the Agricultural Land Commission Act, are often superimposed on these review processes to deal with specific concerns. In addition, authority to deal with any concern not met by the legislation can be reviewed by the Ministry of Environment under the Environment Management Act (RS 14, 1981).

Agricultural Land Commission Act. The Agricultural Land Commission is charged under this Act to set up and monitor the Agricultural Land Reserve (ALR). Section 15(2) of the act states:

> No person shall use agricultural land for any purpose other than farm use, except as permitted by this Act, the regulations or an order of the [Agricultural Land] Commission, on terms the Commissioner may impose.

Regulation 313/78 defines electrical transmission lines as a special use and sets out the form to be used in applying for a special use permit. Unlike the Utilities Commission Act, the Agricultural Land Commission Act does not state any minimum voltage and all new rights-of-way are reviewed regardless of size. No clear guidelines exist for the resolution of interagency conflicts.

Other Special Purpose Acts. Many provincial statutes may affect the interaction between electrical transmission projects and agriculture. The Soil Conservation Act forbids the removal of soil or the placement of fill in the Agricultural Land Reserve without permission from the Agricultural Land Commission. The Weed Control Act requires the control and eradication of noxious weeds growing in the Province. The Water Act requires permits for the use, diversion, and storage of water, the alteration of streams or channels, and the operation of works in and around waterbodies. The Range Act includes provision for the use of Crown range, such as control of livestock and revegetation. The Waste Management Act controls the emission or discharge of effluents and contaminants onto the land or into water or air. The Pesticide Control Act requires permits for the use of pesticides and herbicides, including those used along electrical transmission rights-of-way.

S4.2.2 Conclusions and General Recommendations

Electrical transmission lines do not constitute a major threat to agriculture in B.C. The total amount of land that has been permanently alienated by electrical transmission lines in the Agricultural Land Reserve is on the order of 200 ha. Electrical transmission lines have probably added more than this amount to non intensive agricultural production through the clearing costs of land along rights-of-way. Several impacts, especially irrigation, were found where transmission towers significantly interfered with agricultural operations over areas much larger than the rights-of-way. Mitigation measures are available to greatly lessen many of these. However, in the past these mitigation methods were not often employed. The current system of regulation of major energy energy projects in B.C. by the Utilities Commission is geared for impact management. The Agricultural Land Commission reviews all transmission projects that cross the Agricultural Land Reserve and can stipulate impact management procedures with the Reserve.

The Energy Project Review Process was found to provide a basis for complete and efficient identification of impacts to agriculture. Three areas of general improvement can be identified. The first area involves electrical transmission lines that were not reviewed under the EPRP because they were either too small or constructed before the process was in place. The second area which could be improved concerns the strengthening of agricultural input into the review process. The third area deals with information flow; the EPRP is new and many of the details of the process are known only to a few people.

The following recommendations are aimed at improving the relationship between transmission lines and agriculture:

> RECOMMENDATION 1 - Communications between the Agricultural Land Commission and the EPRP working groups should be formalized to share information and avoid conflicts.
>
> RECOMMENDATION 2 - A brochure should be prepared to briefly outline the different regulatory structures for all linear and non-linear projects.
>
> RECOMMENDATION 3 - Agricultural field officers should continue to be informed of proposed projects, potential impacts, and mitigation options applicable to their areas.

The publication, Guidelines for Linear Development on Agricultural Land (B.C. Ministry of Agriculture) provided a basic framework for including agricultural mitigation measures into the terms and conditions of transmission lines. The following recommendations are aimed at building on this success.

> RECOMMENDATION 4 - The Guidelines for Linear Development on Agricultural Land should be updated and expanded on a regular basis. In particular, separate sections should be made for different types and sizes of projects. More emphasis should be placed on mitigation measures where avoidance is not possible due to concerns for other resources.

Interviews with linear project officers revealed a growing understanding of the needs and wishes of the agricultural industry. Westcoast Transmission Company Ltd. has developed an Environmental Procedures Manual for use in applications, contracts, and inspections of pipelines. B.C. Hydro is in the process of preparing a similar document.

> RECOMMENDATION 5 - The government should encourage self-regulation by linear project operators as much as possible. Environmental procedure manuals are an important tool for linear project self regulation and should therefore be encouraged. These manuals should become part of the tendering documents so construction contractors are bound by them.

Section 4.2.3 of the Main Report review the management of negative and positive impacts of transmission lines, the effectiveness of current regulations, and the success of the regulatory agencies. As agricultural concerns are unlikely to halt linear development in B.C., the impact management approach is seen as a reasonable method of protecting agricultural resources. Additional recommendations are made covering areas such as Building Development, Land Loss, Irrigation and Range Management

S4.3 Pipeline Transmission

S4.3.1 Current Regulation

While few existing or proposed electrical transmission lines are regulated by the National Energy Board (NEB), most of the existing and proposed pipelines in B.C. are actively regulated by the NEB. The NEB Act regulates all pipelines connecting a province with any other and includes all branches and auxiliary facilities. Under this definition the NEB Pipelines Branch regulates the Trans Mountain Pipe Line system, the Westcoast Gas Pipeline system including gathering lines, and the Alberta Natural Gas Company pipeline in the Kootenays. The only pipelines not regulated are the distribution systems operated by B.C. Hydro and Inland Natural Gas Company Ltd. The B.C. Utilities Commission Act creates an overlapping jurisdiction between the Federal and Provincial governments.

Federal Regulation

The National Energy Board Act (C-46, 1959) established the NEB as the basic federal agency responsible for protecting national interests with regard to energy supply, including safety and environmental protection. An amendment was passed in 1982 including a detailed procedure for regulating pipelines under the NEB jurisdiction. This procedure is described in section 4.3.1 of the main report.

One major difference between federal and provincial legislation is the protection of land owners. The NEB Act includes several protections for the land owner not found in the B.C. legislation. Section 74 of the NEB Act, includes the following regulations controlling the acquisition of land for a pipeline.

> (2) A company may not acquire lands for a pipeline under a land acquisition agreement unless the agreement includes provision for:
>
> (a) compensation for the acquisition of lands to be made, at the option of the owner of the lands, by one lump sum payment or by annual or periodic payments of equal or different amounts over a period of time;
>
> (b) review every five years of the amount of any compensation payable in respect of which annual or other periodic payments have been selected;

Many of the NEB requirements have only been incorporated as law since 1980, and to some extent is a new system as is the Utilities Commission. Another major problem is the fact that the NEB works out of Ottawa. None of the farmers interviewed along the Westcoast Pipeline knew what the NEB was or how it was intended to protect their rights.

Provincial Regulation

In theory Provincial regulation of pipelines is the same as a provincial regulation of electrical transmission. Pipelines capable of transporting 16 PJ of energy per year (equivalent to 2,570,000 barrels of crude oil) are regulated projects under the Utilities Commission Act. Smaller pipelines can be regulated under the Guidelines for Linear Developments if so directed by Cabinet. In practice, most small pipelines are handled by inter-agency referral at the local level. Regulated pipeline projects would follow the same procedures as electrical transmission lines The Agricultural Land Commission reviews all new pipeline routes that cross the Agricultural Land Reserve in the same manner as electrical transmission lines.

S4.3.2 Conclusions and General Recommedations

Based on Case Study 1 and the literature review, pipelines were found to present fewer risks and opportunities to agriculture than electrical transmission lines. Compressor and similar stations represented the only significant land losses. This land loss is estimated at less than 200 ha in the Agricultural Land Reserve. Construction phase impacts of pipelines are well documented and compensation measures appear adequate. The only major effect pipeline right-of-ways have on farming operations is through the restriction on buiding development on the right-of-way. For this reason, new pipeline rights-of-way should avoid existing agricultural communities. The most significant impact on agriculture for pipelines observed was the continuing loss of yields immediately over trenches. This problem probably only occurs in fine textured soils or where contractors did not follow approved procedures.

Both the federal and provincial regulatory systems are able to provide for adequate pipeline impact management for agriculture.

The following general recommendations are aimed at improving pipeline/agriculture interactions:[1]

RECOMMENDATION 35 - A clear delineation should be made between federal and provincial jurisdictions over pipelines. Where pipelines have both national and provincial significance a joint process should be developed.

RECOMMENDATION 36 - The strengths of both the provincial and federal regulatory systems should be adopted by all agencies involved with environmental review. Specifically, stronger protection for owners should be adopted by the B.C. Utilities Commission and the federal NEB should utilize the expertise of provincial field staff for assessing agricultural and range concerns.

RECOMMENDATION 37 - All owners, tenants and others with interests along existing and proposed pipelines should be informed of their rights and which agencies are responsible for enforcing those rights. The right of owners to annual compensation under the NEB and broad definition of 'owner' should be publicized.

RECOMMENDATION 38 - Problems with poor drainage and possible continuing yield loss along pipeline routes through fine textured soils should be researched, possibly by a project funded jointly by pipeline operators and government.

RECOMMENDATION 39 - The NEB should be made aware of the Guidelines for Linear Development on Agricultural Land and the use of these guidelines in regulating impact management.

As with electrical transmission lines, impact management is seen as the best option for improving pipeline/agriculture interaction. These interactions are reviewed in Section 4.3.3 and additional recommendations made where appropriate.

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[1] Note: Recommendations 6-34 are contained within the Main Volume report.

S4.4 Highways

S4.4.1 Current Regulations

Normally, the British Columbia Ministry of Transportation and Highways is the developer of new highways in B.C. There are several exceptions to this. Private industrial roads (especially forest and mining roads) have been upgraded into provincial highway status with only minor route modifications.

The following is an Abstract from Environmental Assessment Procedures on Highway Projects in British Columbia, The Coquihalla Highway Project (M.J. Kent, 1982). This describes the review procedures where the Ministry of Highways is the proponent.

> "The British Columbia Government Ministry of Transportation and Highways addresses environmental concerns through two systems. This paper describes the most commonly used Referral Process where environmental agencies are contacted during the functional planning and design stage of highway projects. The other system is the Guidelines for Linear Development. Although no highway project has yet been designated under this process, the procedure and goals have been adopted on a number of projects in the corridor planning phase of some highway projects. The most successful system of addressing and mitigating environmental concerns in the multidisciplinary field is to combine both systems where possible. The paper describes the Hope-Merritt (Coquihalla) Project where the stage process and liaison in the referral method has evolved to ensure adverse environmental problems are avoided and, where potential impacts occur, mitigation and enhancement strategies are adopted in the design. The use of an on-site Environmental Officer during construction ensures that environmental practices are followed and resources protected."

Several other regulatory options are open in cases where other proponents are involved. If the Federal government is a major partner in a highway project, the Federal Environmental Assessment and Review Process would probably be instituted in addition to other review processes. If the road is part of an energy project, the impacts of associated roads may be considered by the B.C. Utilities Commission and the NEB or both. Roads associated with the development of mines would come under review of the Highway (Industrial) Act administered by the B.C. Ministry of Transportation and Highways, and the Mining Regulation Act. Roads associated with forestry development would come under the review of the Highway (Industrial) Act and the Forest Act. While the Highways Act, Highways (Industrial) Act, the Mining Regulation Act and Forest Act apply to roads, there is no direct mention of review of agricultural or environmental impacts in these Acts.

S4.4.2 Conclusions and General Recommendations

Roads and highways have the greatest impact on agriculture of all known projects reviewed. These impacts include large areas of land lost and additional losses due to land fractionation. Roads and highways are necessary for agricultural development. In practice, the existing review processes are equivalent to self-regulation by a linear developer as they do not involve basic approval by any third party or Certificate of Public Convenience by an independent authority. The following recommendations are aimed at improving the interaction between highway development and agriculture.

> RECOMMENDATION 50 - The B.C. Ministry of Agriculture and Food, Farmland Resources Branch, should be added to the Ministry of Transport and Highways interagency contact list. The Farmland Resources Branch would then contact the agricultural and range staff appropriate for any proposed highway.
>
> RECOMMENDATION 51 - The Agricultural Land Commission offers a good mechanism for controlling the alienation of farmland within the ALR but not of areas outside the ALR. The present regulatory structure does not include a clear mechanism for comparing the loss of agricultural land to the loss of forestry and wildlife values. This multidisciplinary weighting of impacts on alternative routes is a key to both provincial and Federal regulation of energy projects and should be applied to highways.

RECOMMENDATION 52 - The highways review process does not have a normal procedure for a land owner to request a minor route realignment. Such a procedure could lessen the amount of land loss caused by a road.

RECOMMENDATION 53 - Industrial roads can have all the negative and positive impacts of Provincial highways. Environmental and agricultural review processes developed for highways should be considered for industrial roads.

RECOMMENDATION 54 - The Ministry of Transport and Highways should prepare an Environmental Procedures manual similar to that used by other linear developers. This manual should include measures for the avoidance and mitigation of agricultural impacts.

RECOMMENDATION 55 - The Guidelines for Linear Development on Agricultural Land should include a section on highways.

The main report includes additional recommendations for specific areas of interaction.

S4.5 Railways

S4.5.1 Current Regulations

There are several regulatory processes governing railway development. Small spur lines are dealt with on a permit basis. Permits are required under many acts for railway development. These include the Agricultural Land Commission Act, the Forest Act, Waste Management Act, Heritage Conservation Act, Water Act, etc. A railway developer may wish to use the Guidelines for Linear Development Act as a way of coordinating permit applications.

Larger Provincially regulated projects would probably be designated under the Guidelines for Linear Development if proposed by B.C. Railway. Major new development by CNR and CPR would be largely subject to federal jurisdiction and review processes. The Canadian Transport Commission is largely concerned with safety and railway operating procedures. The major federal environmental review process for new railways under federal jurisdiction is the Federal Environmental Assessment and Review Process. This process is described in Section 4.5.1 of the main report.

S4.5.2 Conclusions and General Recommendations

Railway projects requiring new rights-of-way are relatively infrequent compared to other linear developments. Normally such new rights-of-ways will be associated with a major industrial, forestry, or mining development. For such projects only minor route changes may be practical to lower agricultural impacts. Avoiding land fractionation is a major consideration here. A potentially greater source of agricultural impact may be associated with expansion of current rights-of-way both in terms of new track and new facilities such as rail yards. Such projects may result in much more agricultural land loss and land fractionation than the development of new right-of-way in remote mining areas. A third source of concern deals with the continuing operation of railways. These concerns include problems such as weed control and vegetation management of the right-of-way, crossings for cattle and farm vehicles and the potention of chemical spills from damaged rail cars.

The following recommendations are aimed at improving agricultural input to decision-making on new railway development, expansion of current rights-of-ways and operation of current facilities.

> RECOMMENDATION 67 - The B.C. Ministry of Agriculture and Food, Farmland Resources Branch, should establish formal communications with the Canadian Transport Commission, B.C. Ministry of Transportation and Highways and Federal Environmental Assessment Review Office. These agencies should be informed of agricultural concerns with the development, expansion and operation of railways. The Farmland Resources Branch could then contact the agricultural and range staff appropriate for a given railway project.
>
> RECOMMENDATION 68 - Railway operators should be encouraged to prepare Environmental Procedures Manuals, including information on cattle and farm vehicle crossings, vegetation management, and contingency plans for chemical spills on agricultural land.
>
> RECOMMENDATION 69 - The Guidelines for Linear Development on Agricultural Land should include a section on railways.
>
> RECOMMENDATION 70 - A mechanism should be found for early agricultural input to the Federal Environmental Assessment and Review Process.

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Number/
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Province of
British Columbia

Ministry of
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OPPORTUNITIES AND RISKS PRESENTED TO AGRICULTURE BY LINEAR DEVELOPMENTS

PROJECT NO. 271315

UNDER

CANADA, BRITISH COLUMBIA SUBSIDIARY AGREEMENT ON

AGRICULTURE AND RURAL DEVELOPMENT

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The responsibility for the report as written and all conclusions reached herein is the consultant's alone, and does not necessarily reflect the opinions of those who assisted during the course of this investigation and the federal and provincial governments which funded the study.

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1.0 INTRODUCTION

In September of 1982 TERA Environmental Consultants Ltd. received a contract under the Agriculture and Rural Development Subsidiary Agreement, Research Program to investigate the Opportunities and Risks Presented to Agriculture by Linear Developments. The need for this project was created by the unprecedented number of large scale transmission line and pipeline projects that have been proposed for British Columbia. It was known that a variety of positive and negative agricultural impacts can be attributed to large scale linear projects. However, in order to optimize the effects of these projects, further information was required. The project had the following objectives:

> To provide an overview of the type, size, length and location of existing and proposed linear developments in the province and the areal extent of their effects on agriculture.
>
> To identify the potential impacts and effects presented to agriculture by linear developments in British Columbia.
>
> To prepare an annotated bibliography on the opportunities and risks presented by linear developments.
>
> To recommend changes in existing policies, guidelines and regulations, which would lead to greater realization of potential opportunities and mitigation of potential risks.

The study was divided into three phases. Section 2.0 of the main volume reports on the findings of the inventory phase. Section 3.0 reports on two case studies that were conducted. Government policies, regulations, and guidelines are reviewed in Section 4.0 which includes recommendations for changes to the current regulatory structure. The study findings are presented in three volumes consisting of a Summary, Main Volume and Appendix volume.

The study team was led by Michael Goldstein, P.Ag. Other team members were Helmut Urhahn, Janet Waterman, James LaMorte and Barbara Element.

2.0 PHASE 1 INVENTORY

2.1 Inventory of Existing and Proposed Linear Developments

This section contains a discussion of study methodology and is an overview of current and proposed linear developments in British Columbia. The main emphasis is on electrical transmission lines of 230 kV and higher voltages and natural gas and oil transmission pipelines. Highway and railway developments are reviewed in a short summary at the end of this section. The province is divided into 8 Agricultural Reporting Regions. For each region, important agricultural pursuits and resources are described and the magnitude of the interaction between agriculture and electrical and gas transmission lines is reviewed. Where possible, the basic issues that will arise due to the proposed projects are predicted.

2.1.1 Methodology and Study Limitations

The accompanying linear projects overview map was prepared starting from a 1:1,000,000 scale map of the Agricultural Land Reserve of B.C. in 1976 supplied by the Ministry of Environment. This map was updated by modifying the ALR to reflect inclusions and deletions to the ALR between 1976 and April 1, 1982. In general, maps of existing and proposed projects supplied by linear operators were schematic in nature and did not allow for accurate placement of linear projects on the base map. Existing projects were located using the following maps in order of preference: Aeronautical charts, black and white LANDSAT satellite mosaics, and National Topographic Series Maps at scales of 1:250,000, 1:125,000 and 1:50,000. Agricultural Reporting Region boundaries were shown on the map. (See Figure 1-1)

Areas of rights-of-way and stations were calculated for comparative purposes. The total length of each electrical transmission line and pipeline and the length within the ALR were measured on the base map with a precision map measuring device. The area affected by linear developments was estimated by multiplying the length of the linear development by the following average rights-of-way widths:

Electrical transmission lines	
300-500 kV	64m
230 - 300 kV	42m
Pipelines	
transmission	15m
gathering	10m

Major electrical transformer stations and compressor and pumping stations were drafted onto the base map based solely on the information supplied by linear operators. No information was readily available on the size of individual stations. Low elevation air photographs of two electrical transformer stations, two large gas compressor stations and one oil pumping station were used to estimate the size of such stations. The sizes of these stations ranged between 8 and 16 ha with an average about 10 ha[1]. While all linear projects of a single type and size are often very similar, stations along a single project may vary greatly in size and function. In this overview, an average size of all major linear development stations of 10 ha was assumed.

The magnitude of agriculture/linear project interaction could be assessed by comparing the land area in the ALR to the portion of this area that is shared with rights-of-way for electric, gas and oil transmission. It should be noted that many impacts are associated with areas much larger or smaller than the right-of-way. Impacts on irrigation can affect much larger areas than the right-of-way. Impacts caused by transmission tower bases affect only a small portion of the rights-of-way. Some impacts such as land clearing and prohibition on building development are closely associated with the size of the right-of-way. It is felt that the area of right-of-way within the ALR is a good relative measure of the magnitude of interaction at the overview level.

---

[1] The legal size of the land parcel for compressor stations was approximately twice the size of the actual station. Information on land ownership around electrical and oil stations was not available.

There are many sources of error in the inventory methodology as described above. The first major source of error is the information supplied by linear operators. There is a possibility that existing projects were overlooked. A greater source of error involves proposed projects. Plans for linear projects often are in a constant state of flux. It is not unusual for routes to be changed even during construction. Also, the regulatory process introduces great uncertainties. The proposed projects as given in this report represent what is next on linear developer agenda. Projects such as the Liard Hydroelectric, Hat Creek Coal Generation, a petrochemical feedstock pipeline to Prince Rupert, and the Kemano Completion Project, have not been included because current market forces have placed these projects on "the back burner". A rapid increase in the world demand for raw materials could make these and other projects a reality before the year 2000. Even when a proposed project is included on the overview map, its location could be changed greatly.

Errors exist in the drafting of the location of existing projects and ALR's. Measurement and compilation errors are thought to be small. The total length of 500 kV transmission lines was measured within 5% of the value supplied by B.C. Hydro. Many of the drafting and measuring errors are random and will tend to cancel out. It is felt that the data generated in this report is accurate to one significant figure. No rounding was done to avoid rounding errors when the figures were added.

2.1.2 British Columbia

The Canadian Agricultural Economic Research Council estimates 23% of B.C. economic activity is directly or indirectly generated by agriculture.[1] With wholesale sales of $2.6 billion, agriculture ranks third behind forestry and mining. In times of recession, the importance of agriculture relative to forestry and mining increases. The major impetus of agriculture is not its relatively small land base of about 4 million hectares but the readily available markets based on the forestry and mining industries. These industries stimulate the agricultural industry but also compete with it for flat, accessible agriculturally capable land and rangeland.

---

[1] Census of Agriculture for B.C., (1981), Economics Branch, Ministry of Agriculture and Food, Victoria, B.C.

Table 2-1 presents agricultural statistics for B.C. The heavy commitment of land to forage and grain production is evident. Many commodities grown in British Columbia take on importance when viewed regionally. Grain is very important in the Peace but relatively unimportant in the Cariboo. Tree fruits are important in the Okanagan, but relatively unimportant in other regions. For this reason, regional reviews of the magnitude of agriculture/linear project interaction are considered more meaningful than a province-wide view. The following sections review the current and proposed linear projects for each of the eight Agricultural Reporting Regions in B.C. Table 2-2 gives the statistics for existing and proposed linear projects in B.C. Similar tables are given for each region.

Table 2-2 shows that the system of electrical transmission lines could increase by 75% in the next twenty years. The increase in electrical transmission right-of-way within the ALR is expected to be only 40%. The major reason for this difference is that major hydroelectric generation projects are planned for remote areas where agricultural land is scarce and agricultural reserves have not been set up. Key regions where agricultural development may be increased as a result of development of electrical transmission lines are the Cariboo, Omineca, and Peace Regions. Key regions where negative impacts on agriculture could be caused by linear development are the Mainland, (Lower Fraser Valley), Vancouver Island (southeastern section) and the Okanagan (east side of Okanagan Lake).

Pipelines show a smaller potential increase than electrical transmission lines, about 37%. The increase in pipeline right-of-way within the ALR would be about 30%. Pipeline rights-of-way are narrower than electrical transmission lines. Since pipelines are completely buried, they have more impact on soil compaction but much less impact on field operations than electrical lines. In general, pipeline development will have less of an effect both positively and negatively than electrical transmission line development. An exception to pipelines having less of an effect on agriculture may be on Vancouver Island. This would be due to the extent of pipelines that may be developed once natural gas is introduced to the

Island. Another region where pipeline/agriculture interactions will be important is the Peace region where the sedimentary geology of the prairie soils provides both a source of oil and gas and a good medium for pipeline construction.

Electrical transformer stations on high voltage transmission lines, compressor stations on gas pipelines and pumping stations on oil pipelines take up only a small fraction of the land as compared with their associated right-of-way; less than 1%. This area is more significant because these stations are single use, and, unlike the right-of-way, exclude agricultural development. Another factor is that these stations occur more frequently within the ALR than rights-of-way in general. Approximately 30% of rights-of-way are within the ALR, while half of the major stations are within the ALR. Several factors will tend to maintain this pattern. In general, stations require flat land with good access. They are also needed where lines meet.

A major factor in determining the location of future linear projects and stations is the location of existing facilities. A systems approach is used in locating new linear projects which are viewed as additions to the systems rather than independent projects. Normally systems are operated by a single company in B.C.

Agriculture shares the use of rights-of-way with electrical transmission lines and pipelines on about 0.4% of the ALR. If proposed rights-of-way are added to this, about 0.5% of the ALR is shared by agriculture and linear projects. Only about 0.006% of the ALR has been permanently alienated by electrical and pipeline stations. By themselves, linear projects are not a great threat to agriculture in B.C. They form part of the increasing pattern of non-farm development that competes for land resources with agriculture. It should be noted that many of these non-farm developments increase the market for agricultural products in B.C. This suggests that the policy should be to improve the joint use of rights-of-way, rather than excluding linear projects from the ALR. The key to such a policy is the cooperation and commitment of linear project operators to coordinated resource use of their rights-of-way.

TABLE 2-1 B.C. Agricultural Statistics: 1981

Population[1]	#	2,744,467
Farms with Sales over $2500[1]	#	13,597
Total Value of Sales	$	798,877,000
Total Land Area[1]	ha	89,310,362
ALR Area[2]	ha	4,700,230
Arable Land[3] (Improved Class 1-4)	ha	3,598,067
Improved Farmland[1]	ha	946,350
Irrigated[1]	ha	100,478
Crown Range[4] (Approx.)	ha	11,015,309
Major Crops[1]		
grain	ha	170,067
silage corn	ha	11,729
forage seed	ha	16,777
hay	ha	290,238
vegetables and potatoes	ha	11,377
tree and small fruits	ha	17,101
Livestock[1]		
beef cattle[5]	#	661.822
dairy cattle[6]	#	128,019
chickens	#	9,975,871

Source: 1. Census of Agriculture for British Columbia, 1981.

2. British Columbia Agriculture Land Commission, Cumulative Statistics, April 1, 1981. (Agriculture Land Reserve)

3. Canada Land Inventory Classes 1 to 4 inclusive, "improved" as defined in Agricultural Land Capability in British Columbia, B.C.M.A.F. September, 1976.

4. Range Management Branch, B.C. Ministry of Forests.

5. Includes beef; cows, heifers, steers, bulls, and calves.

6. Includes dairy cows and heifers.

Table 2-2 B.C. Linear Development Statistics

RIGHTS-OF-WAY	TOTAL		ALR	
	km	ha	km	ha
Electrical				
Existing				
500 and 360 kV	4,694[1]	30,041	1,652	10,572
230 to 287 kV	2,164	9,089	895	3,759
Proposed				
500 and 360 kV	4,062	25,996	640	4,096
230 to 287 kV	455	1,911	210	882
Total	11,375	67,037	3,397	19,309
Pipeline				
Existing (transmission)	5,325	7,987	1,795	2,692
(gathering[2])	970	970	370	370
Proposed transmission	2,114	3,165	470	705
Total	8,409	12,128	2,635	3,767
MAJOR STATIONS				
Electrical				
Existing	27	270	10	100
Proposed	5	5	3	30
Total	32	320	13	130
Pipelines				
Existing	26	260	12	120
Proposed	7	70	6	60
Total	33	330	18	180

TOTALS

Right-of-way	79,165ha	23,076ha
Total land area	89,310,362ha	4,700,230ha
% Right-of-way	0.09%	0.49%
Stations	650ha	310ha
% in Stations	0.0007%	0.006%

[1] Data generated by author, see section 2.1.1 for methodology

[2] Gathering lines registered by the National Energy Board

The Kootenay Region

Agriculture in the Kootenay Region developed to meet local needs and the needs of mining communities in the Region. The region has a long tradition of small farms. In the 1920's and 1930's the Doukhobors established a system of productive communal farms and fruit packing, canning and jam operations. In the 1930's an extensive dyking project reclaimed the Creston Valley bottomland which became the most productive farmland in the Region. Improved transportation systems in the 1940's and 1950's brought in agricultural products from other regions. The result has been a rationalization of farming in the Kootenays with a stronger concentration in beef production.

One additional 500kV and several 230kV transmission lines and one additional gas transmission line are proposed for the Kootenay Region. The 500kV transmission line is to be completed in 1985 and connects the Cranbrook Substation to the Alberta border via Crowsnest Pass. There are several proposed 230kV lines, the longest of which follows the Rocky Mountain Trench north from Cranbrook.

The proposed pipeline follows the existing Alberta Natural Gas Pipeline between Corbin and Kingsgate. Both of these projects will cross the important agricutural area southeast of Cranbrook.

Electrical transmission lines have and will continue to supply an important source of grazing land to the region. At the same time, electrical transmission lines would greatly disrupt field operation in the limited land areas capable of grain and vegetable production. Careful routing of proposed transmission lines could avoid most of the cultivatable land and increase grazing capacities on rangeland. Lack of weed control along rights-of-way in grazing areas is a significant problem. Pipelines will not greatly affect agriculture in the Kootenay Region.

TABLE 2-3 Kootenay Agricultural Reporting Region Agricultural Statistics

Population[1]	#	105,768
Farms with Sales over 2500[1]	#	643
Total Value of Sales[1]	$	21,947,000
Total Land Area[1]	ha	5,158,403
ALR Area[2]	ha	338,030
Arable Land[3] (Improved Class 1-4)	ha	225,283
Improved Farmland [1]	ha	36,285
Irrigated[1]	ha	9,529
Crown Range[4](Approx)	ha	840,011
Major Crops		
grain	ha	3,828
silage corn	ha	396
forage seed	ha	646
hay	ha	16,094
vegetables and potatoes	ha	168
tree and small fruits	ha	489
Livestock[1]		
beef cattle[5]	#	37,743
dairy cattle[6]	#	3,757
chickens	#	56,851

Source:
1. Census of Agriculture for British Columbia, 1981.
2. British Columbia Agriculture Land Commission, Cumulative Statistics, April 1, 1981. (Agriculture Land Reserve)
3. Canada Land Inventory Classes 1 to 4 inclusive, "improved" as defined in Agricultural Land Capability in British Columbia, B.C.M.A.F. September, 1976.
4. Range Management Branch, B.C. Ministry of Forests.
5. Includes beef; cows, heifers, steers, bulls, and calves.
6. Includes dairy cows and heifers.

TABLE 2-4 Kootenay Agricultural Reporting Region
Linear Development Statistics

RIGHTS-OF-WAY	TOTAL		ALR	
	km	ha	km	ha
Electrical				
Existing				
500 and 360 kV	425[1]	2,720	115	736
230 to 287 kV	470	1,974	140	588
Proposed				
500 and 360 kV	70	448	20	128
230 to 287 kV	120	504	105	441
Total	1,085	5,646	380	2,253
Pipeline				
Existing (transmission)	580	870	210	315
Proposed transmission	130	195	20	30
Total	710	1065	230	345
MAJOR STATIONS				
Electrical				
Existing	5	50	2	20
Proposed	0	0	0	0
Total	5	50	2	20
Pipelines				
Existing	0	0	0	0
Proposed	0	0	0	0
Total	0	0	0	0

TOTALS

Right-of-way	6,711ha	2,598ha
Total land area	5,158,403ha	338,030ha
% Right-of-way	0.13%	0.77%
Stations	50ha	20ha
% in Stations	0.0001%	0.006%

[1] Data generated by author, see section 2.1.1 for methodology
[2] Gathering lines registered by the National Energy Board

The Okanagan Region

The Okanagan Region ranks second in terms of farm income. The southern portion of the region boasts a vigorous tree fruit and vegetable industry, which is dependent on irrigation. The northern portion of the region produces livestock, grains, forage crops and vegetables. Land use conflicts are intense in the Okanagan Region. This is especially true of the agriculturally capable areas of the Okanagan, Similkameen, Shuswap and Salmon River valleys. Existing and proposed rights-of-way occupy 1510 ha within the Agricultural Land Reserve or 0.5% of the ALR in the region.

There is a 230 kV transmission line and highway proposed for the east side of Okanagan Lake. This corridor is now used for a gas pipeline and electrical transmission line. Use of shared or adjacent rights-of-way may not be advisable in this corridor but a common corridor study of linear developments on the east side of Okanagan Lake would be of value. Research into the cultivation of dwarf tree fruit varieties and irrigation design under high voltage transmission lines would be of benefit to agriculture in the region. Greater use of large automated irrigation systems on forage land is also anticipated. Both existing and proposed electrical transmission lines may interfere with these systems. Lack of weed control along rights-of-way is also a significant problem. Pipelines are not a major agricultural issue in the Okanagan Region.

TABLE 2-5 The Okanagan Agricultural Reporting Region Agricultural Statistics

Population[1]	#	270,137
Farms with sales over 2500[1]	#	3,620
Total Value of Sales[1]	$	137,207,000
Total Land Area[1]	ha	5,954,853
ALR Area[2]	ha	303,698
Arable Land[3] (Improved Class 1-4)	ha	275,842
Improved Farmland[1]	ha	103,963
Irrigated[1]	ha	35,132
Crown Range (Approx.)[4]	ha	440,606
Major Crops[1]		
grain	ha	6,725
silage corn	ha	2,668
forage seed	ha	418
hay	ha	34,578
vegetables and potatoes	ha	1,034
tree and small fruits	ha	11,932
Livestock[1]		
beef cattle[5]	#	96,453
dairy cattle[6]	#	14,397
chickens	#	560,138

Source:
1. Census of Agriculture for British Columbia, 1981.
2. British Columbia Agriculture Land Commission, Cumulative Statistics, April 1, 1981. (Agriculture Land Reserve)
3. Canada Land Inventory Classes 1 to 4 inclusive, "improved" as defined in Agricultural Land Capability in British Columbia, B.C.M.A.F. September, 1976.
4. Range Management Branch, B.C. Ministry of Forests.
5. Includes beef; cows, heifers, steers, bulls, and calves.
6. Includes dairy cows and heifers.

Table 2-6 The Okanagan Agricultural Reporting Region
Linear Development Statistics

RIGHTS-OF-WAY	TOTAL km	TOTAL ha	ALR km	ALR ha
Electrical				
Existing				
500 and 360 kV	685[1]	4,384	92	589
230 to 287 kV	170	714	100	420
Proposed				
500 and 360 kV	0	0	0	0
230 to 287 kV	150	630	80	336
Total	1,005	5,728	272	345
Pipeline				
Existing (transmission)	360	540	110	165
Proposed transmission	0	0	0	0
Total	360	540	110	165

MAJOR STATIONS	(#)	ha	(#)	ha
Electrical				
Existing	2	20	2	20
Proposed	1	10	1	10
Total	3	30	3	30
Pipelines				
Existing	0	0	0	0
Proposed	0	0	0	0
Total	0	0	0	0

TOTALS		
Right-of-way	6,268ha	1,510ha
Total Land Area	5,954,853ha	303,698ha
% in Rights-of-way	0.11%	0.49%
Stations	30ha	30ha
% in stations	0.0005%	0.010%

1 Data generated by author, see section 2.1.1 for methodology
2 Gathering lines registered by the National Energy Board

The Island Region

The southeast portion of Vancouver Island has some of the best agricultural land in the Province. Intensive agriculture including dairy, tree fruits and berry crops, and vegetables is scattered through lowlying areas from Campbell River to Victoria. In addition to the Lower Fraser Valley and the Okanagan Valley, Vancouver Island has the greatest land use conflicts in B.C.

The rapid development of Vancouver Island has lead to construction of the Cheekeye to Dunsmuir electrical transmission line which has been connected to Victoria by two 500 kV transmission lines. It also seems likely that a gas pipeline will be built to the Island and a gas distribution system will be developed between Campbell River and Victoria. These gas pipelines may be routed extensively through the ALR on the Island. A major highway development is proposed from Nanaimo to Campbell River. In the more distant future, the Homathko hydroelectric project will probably affect the more remote and undeveloped areas of the Region. This project could encourage agricultural development if access and land tenure is made available. Existing and proposed rights-of-way occupy 1,510 ha in the Agricultural Land Reserve or about 0.7% of the ALR in the region.

Studies should be conducted into the advisability of shared or adjacent rights-of-way on the east side of Vancouver Island. Some specialized land uses such as seed cone orchards which are found on Vancouver Island may be well suited to electrical transmission rights-of-way. Other uses such as forest transplant nurseries may be hard to develop on electrical transmission rights-of-way. Interference with irrigation systems, land loss, and restrictions on developments of greenhouses on electrical transmission rights-of-way could be important negative impacts.

TABLE 2-7 The Island Agricultural Reporting Region
Agricultural Statistics

Population[1]	#	1,494,741
Farms with sales over 2500[1]	#	1,191
Total Value of Sales[1]	$	62,111,000
Total Land Area[1]	ha	5,697,399
ALR Area[2]	ha	111,505
Arable Land[3] (Improved class 1-4)	ha	201,698
Cultivated Land[1]	ha	25,757
Irrigated[1]	ha	4,343
Crown Range (Approx.)[4]	ha	0
Major Crops[1]		
grain	ha	924
silage corn	ha	536
forage seed	ha	173
hay	ha	11,725
vegetables and potatoes	ha	981
tree and small fruits	ha	299
Livestock[1]		
beef cattle[5]	#	20,745
dairy cattle[6]	#	13,056
chickens	#	1,005,154

Source: 1. Census of Agriculture for British Columbia, 1981.

2. British Columbia Agriculture Land Commission, Cumulative Statistics, April 1, 1981. (Agriculture Land Reserve)

3. Canada Land Inventory Classes 1 to 4 inclusive, "improved" as defined in Agricultural Land Capability in British Columbia, B.C.M.A.F. September, 1976.

4. Range Management Branch, B.C. Ministry of Forests.

5. Includes beef; cows, heifers, steers, bulls, and calves.

6. Includes dairy cows and heifers.

TABLE 2-8 The Island Agricultural Reporting Region
Linear Development Statistics

	TOTAL		ALR	
RIGHTS OF WAY	km	ha	km	ha
Electrical				
Existing				
500 and 360 kV	300[1]	1,920	80	512
230 to 287 kV	70	294	40	168
Proposed				
500 and 360 kV	0	0	0	0
230 to 287 kV	0	0	0	0
Total	370	2,214	120	680
Pipeline				
Existing	0	0	0	0
Proposed	280	420	70	105
Total	280	420	70	105
MAJOR STATIONS				
Electrical	(#)	(ha)	(#)	(ha)
Existing	4	40	2	20
Proposed	0	0	0	0
Total	4	40	2	20
Pipelines				
Existing	0	0	0	0
Proposed	0	0	0	0
Total	0	0	0	0
TOTALS		ha		ha
Right-of-way		2,634ha		785ha
Total Land Area		5,697,399ha		111,505ha
% in Rights of Way		0.04%		0.70%
Stations		40ha		20ha
% in Stations		0.001%		0.018%

[1] Data generated by author, see section 2.1.1 for methodology

[2] Gathering lines registered by the National Energy Board

The Mainland Region

The Mainland Region produces over half of the province's agricultural income on only 5% of the province's arable land. This intensive production is concentrated in the Lower Fraser Valley. Much of the production of the Lower Fraser Valley goes to Vancouver. The growth of Vancouver has lead to high land prices and stiff competition for the use of arable land by non-agricultural users. Key components to agriculture in the Lower Fraser Valley are dairy, vegetables, greenhouse production, poultry, and small fruits. The Valley has as many beef cattle as dairy cows, but in general, beef cattle are kept on improved pasture and not turned out into rangeland. The reason for this is that high quality beef rangeland is comparatively non-existant in the Mainland Region compared to other regions.

Use of forested land for beef cattle grazing is, and will continue to be, minimal in the Mainland Region. Good rangelands exist in the region for sheep and goats. Electrical transmission lines could have a positive impact in developing sheep and goat range. The major negative impacts resulting from electrical transmission lines include land loss and interference with field operations. Pipelines will result in the loss of some yields.

Unfortunately these negative impacts will be concentrated in the Lower Fraser Valley. The valley bottom now contains 3 major transmission lines, 3 major pipelines, 3 railways, and 2 major highways. Unfortunately each linear project operator has acted independently from the others. The result is that the Valley is a maze of projects. Since most of these rights-of-way are well established, most of the opportunities for mitigating their impacts have passed. Although few projects have been planned for the Lower Fraser Valley, the pressure to utilize this wide (20 km) corridor through the Coast Mountains will increase with the size of Vancouver. Existing and proposed rights-of-way occupy about 3,071ha within the Agricultural Land Reserve or about 1.95% of the ALR in the region.

Agriculture and linear developments are concentrated by physical and market forces in the Lower Fraser Valley. Special mitigation measures such as joint rights-of-way and special tower designs and position may be advisable in this area.

Proposals in this Region include the Westcoast Island gas pipeline which poses neither opportunities nor risks to agriculture and the competing B.C. Hydro Gas pipeline. The planned location of this pipeline crosses through the agricultural heartland of the Lower Fraser Valley. About 75 ha of right-of-way of the proposed B.C. Hydro Island Gas Pipeline is in the Lower Mainland ALR.

TABLE 2-9 The Mainland Agricultural Reporting Region Agricultural Statistics

Population[1]	#	1,438,648
Farms with sales over 2500[1]	#	4,256
Total Value of Sales[1]	$	423,864,000
Total Land Area[1]	ha	2,579,719
ALR Area[2]	ha	157,761
Arable Land[3]	ha	148,909
(Improved Class 1-4)		
Land[1]	ha	81,099
Irrigated[1]	ha	8,265
Crown Range (Approx.)[4]	ha	1,662
Major Crops[1]		
grain	ha	3,440
silage corn	ha	7,422
forage seed	ha	521
hay	ha	26,186
vegetables and potatoes	ha	8,514
tree and small fruits	ha	4,236
Livestock[1]		
beef cattle[5]	#	76,034
dairy cattle[6]	#	82,993
chickens	#	7,991,733

Source:
1. Census of Agriculture for British Columbia, 1981.
2. British Columbia Agriculture Land Commission, Cumulative Statistics, April 1, 1981. (Agriculture Land Reserve)
3. Canada Land Inventory Classes 1 to 4 inclusive, "improved" as defined in Agricultural Land Capability in British Columbia, B.C.M.A.F. September, 1976.
4. Range Management Branch, B.C. Ministry of Forests.
5. Includes beef; cows, heifers, steers, bulls, and calves.
6. Includes dairy cows and heifers.

TABLE 2-10 The Mainland Agricultural Reporting Region
Linear Development Statistics

	TOTAL		ALR	
RIGHTS OF WAY	km	ha	km	ha
Electrical				
Existing				
500 and 360 kV	885[1]	5,664	340	2,176
230 to 287 kV	190	798	60	252
Proposed				
500 and 360 kV	710	4,544	35	224
230 to 287 kV	0	0	0	0
Total	1,785	11,006	435	2,652
Pipeline				
Existing	570	885	250	382
Proposed	100	150	25	37
Total	570	1,035	275	419
MAJOR STATIONS				
Electrical	(#)	(ha)	(#)	(ha)
Existing	5	50	2	20
Proposed	1	10	1	10
Total	6	60	3	30
Pipelines				
Existing	3	30	1	10
Proposed	1	10	0	0
Total	4	40	1	10

TOTALS

	TOTAL	ALR
Right-of-Way	12,041ha	3,071ha
Total Land Area	2,579,719ha	157,761ha
% in Rights-of-Way	0.47%	1.95%
Stations	90ha	40ha
% in Stations	0.003%	0.025%

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[1] Data generated by author, see section 2.1.1 for methodology
[2] Gathering lines registered by the National Energy Board

The Thompson Region

The Thompson region has a colourful history of ranching. The industry was developed during the 1860's and 1870's. Ranches were located in areas where gravity feed, flood irrigation systems could be operated. Low elevation grasslands below 366m (1200 feet) are extensively used for spring and fall grazing. The lack of seasonal forage is a major limiting factor in beef production. More recently, large automated irrigation systems such as large, centre pivot systems have greatly increased hay production.

The Thompson Region has several concentrations of linear projects. The Kelly Lake Substation connects 10 electrical transmission lines and three more 500 kV lines are proposed. Four major pipelines cross the region and a proposed gas pipeline to Vancouver Island passes through the region. A new highway between Hope and Kamloops is also proposed. In total, 4,133 ha within the Agricultural Land Reserve or about 0.75% of the ALR in the region is occupied by linear developments. A significant portion of this and the remaining 8,000 ha of right-of-way is on land that is used for cattle grazing.

Several important agricultural issues are associated with the extensive right-of-way in the Region. In grazing areas, existing and proposed electrical transmission rights-of-way can provide increased grazing capacities. However, in areas of cultivation and forage production, increased use of automated irrigation systems will increase the conflict between agriculture and electrical transmission towers. Weed control along transmission lines is also a significant issue. The effects of the proposed electrical transmission lines entering and leaving Kelly Lake substation and the proposed Hope-Kamloops highway, will largely be determined by which routes are chosen.

In general, the Thompson Region has well developed linear systems and many of the future impacts, both positive and negative, will be associated with the widening of existing rights-of-way.

TABLE 2-11 The Thompson Agricultural Reporting Region
Agricultural Statistics

Population[1]	#	111,911
Farms with sales over 2500[1]	#	718
Total Value of Sales[1]	$	37,567,000
Total Land Area[1]	ha	6,142.844
ALR Area[2]	ha	594,043
Arable Land[3] (Improved Class 1-4)	ha	304,239
Improved Land[1]	ha	102,087
Irrigated[1]	ha	26,317
Crown Range (Approx.)[4]	ha	889,223
Major Crops[1]		
grain	ha	1,667
silage corn	ha	359
forage seed	ha	291
hay	ha	31,181
vegetables and potatoes	ha	370
tree and small fruits	ha	110
Livestock[1]		
beef cattle[5]	#	145,196
dairy cattle[6]	#	1,516
chickens	#	88,985

Source: 1. Census of Agriculture for British Columbia, 1981.

2. British Columbia Agriculture Land Commission, Cumulative Statistics, April 1, 1981. (Agriculture Land Reserve)

3. Canada Land Inventory Classes 1 to 4 inclusive, "improved" as defined in Agricultural Land Capability in British Columbia, B.C.M.A.F. September, 1976.

4. Range Management Branch, B.C. Ministry of Forests.

5. Includes beef; cows, heifers, steers, bulls, and calves.

6. Includes dairy cows and heifers.

TABLE 2-12 The Thompson Agricultural Reporting Region Linear Development Statistics

	TOTAL		ALR	
RIGHTS OF WAY	km	ha	km	ha
Electrical				
Existing				
500 and 360 kV	1005[1]	6,432	365	2,336
230 to 287 kV	674	2,831	245	1,029
Proposed				
500 and 360 kV	490	3,136	120	768
230 to 287 kV	0	0	0	0
Total	2,169	12,399	730	4,133
Pipeline				
Existing	715	1,072	200	300
Proposed	210	315	20	30
Total	925	1,387	220	330
MAJOR STATIONS	(#)	(ha)	(#)	(ha)
Electrical				
Existing	4	40	2	20
Proposed	0	0	0	0
Total	4	40	2	20
Pipelines				
Existing	5	50	3	30
Proposed	0	0	0	0
Total	5	50	3	30

TOTALS	TOTAL	ALR
Right-of-Way	13,786ha	4,463ha
Total Land Area	6,142,844ha	594,043ha
% in Rights-of-Way	0.22%	0.75%
Stations	90ha	50ha
% in Stations	0.001%	0.008%

1 Data generated by author, see section 2.1.1 for methodology
2 Gathering lines registered by the National Energy Board

The Cariboo Region

The Cariboo Region is similar to the Thompson Region in that it has a long history of beef ranching. Beef ranching will continue to be the chief agricultural activity for the foreseeable future. Virtually all of the Fraser Plateau which occupies the eastern 2/3 of the Region is used as rangeland for cattle. Key agricultural resources include the low elevation grasslands that are used for spring and fall grazing and areas of class 1 and 2 land along the Fraser and Chilcotin Rivers which require irrigation. Most of the area outside of the ALR is forested land where electrical transmission lines would be beneficial for cattle grazing. Over half of the Cariboo Region has not been surveyed for agricultural capability.

In most of the province, agriculture and linear developments share restricted valley bottoms. In the Cariboo they share an extensive plateau. Several large electrical transmission projects are planned for the region. An additional 500 kV line will join the 3 existing lines between Prince George and Kelly Lake. Power for northern hydroelectric projects and power from the proposed Homathko hydroelectric project in the central Cariboo will be routed South through the Cariboo. These projects could double the areas of rights-of-way in the Cariboo. Most of these rights-of-way could be a benefit to agriculture. Interference with irrigation, land loss, and soil disruption in key low elevation areas could cause major negative impacts. The proposed pipeline would not greatly affect agriculture. Existing and proposed rights-of-way occupy 5,690ha within the Agricultural Land Reserve or about 0.62 of the ALR in the Region.

Key aspects of the linear project/agricultural interaction will be the location of a major substation west of the Fraser River, (this substation is referred to as the Alexis Creek Station by B.C. Hydro) and routing of the proposed Northern Transmission and Homathko electrical transmission lines away from low elevation land with a high capability for irrigated agriculture.

TABLE 2-13 The Cariboo Agricultural Reporting Region Agricultural Statistics

Population[1]	#	62,299
Farms with sales over 2500[1]	#	1,018
Total Value of Sales[1]	$	26,649,000
Total Land Area[1]	ha	9,429,445
ALR Area[2]	ha	919,483
Arable Land[3] (Improved Class 1-4)	ha	779,849
Improved Farmland[1]	ha	90,952
Irrigated[1]	ha	15,783
Crown Range (Approx.)[4]	ha	4,770,465
Major Crops[1]		
grain	ha	1,234
silage corn	ha	313
forage seed	ha	163
hay	ha	36,984
vegetables and potatoes	ha	83
tree and small fruits	ha	9
Livestock[1]		
beef cattle[5]	#	127,812
dairy cows[6]	#	3,606
chickens	#	29,681

Source:
1. Census of Agriculture for British Columbia, 1981.
2. British Columbia Agriculture Land Commission, Cumulative Statistics, April 1, 1981. (Agriculture Land Reserve)
3. Canada Land Inventory Classes 1 to 4 inclusive, "improved" as defined in Agricultural Land Capability in British Columbia, B.C.M.A.F. September, 1976.
4. Range Management Branch, B.C. Ministry of Forests.
5. Includes beef, cows, heifers, steers, bulls, and calves.
6. Includes dairy cows and heifers.

TABLE 2-14 The Cariboo Agricultural Reporting Region Linear Development Statistics

	TOTAL		ALR	
RIGHTS-OF-WAY	km	ha	km	ha
Electrical				
Existing				
500 and 360 kV	424[1]	2,713	330	2,112
2,112				
230 to 287 kV	260	1,092	200	840
Proposed				
500 and 360 kV	1,012	6,477	265	1,696
230 to 287 kV	50	210	25	105
Total	1,746	10,492	820	4,753
Pipeline				
Existing	780	1,170	570	855
Proposed	122	183	55	82
Total	902	1,353	625	937
MAJOR STATIONS				
Electrical	(#)	(ha)	(#)	(ha)
Existing	0	0	0	0
Proposed	2	10	2	10
Total	1	10	1	10
Pipelines				
Existing	5	50	3	30
Proposed	1	10	1	10
Total	6	60	4	40

TOTALS

	TOTAL	ALR
Right-of-way	11,845	5,690
Total Land Area	9,429,445ha	919,483ha
% in Rights-of-Way	0.12%	0.62%
Stations	70ha	50ha
% in Stations	0.001%	0.005%

[1] Data generated by author, see section 2.1.1 for methodology

[2] Gathering lines registered by the National Energy Board

The Omineca Region

The Omineca Region covers over one third of British Columbia. Only the southern portion of the region has been surveyed for agricultural capability. Agricultural land, predominantly classes 4 and 5, is concentrated in the Fraser, Nechako, Bulkley and Skeena River valleys. Agriculture held a dominant position in the early development of northwestern B.C. Although agriculture is less important economically than forestry, mining, or tourism, it helps to stabilize the region's economy. Grain and forage seeds were the first crops produced for sale outside the region. Today beef is the major export. The Region supplies most of its own milk, poultry and a significant portion of its short season vegetables.

Several major linear developments are planned for the Omineca Region. The largest of these is the Stikine-Iskut transmission project. The proposed lines would connect hydroelectric generation stations on the Stikine and Iskut Rivers to Terrace and Telkwa (Smithers). The second major project is a gas pipeline proposed by Dome Petroleum and Westcoast Transmission to link Alberta Gas to a Liquefied Natural Gas (LNG) terminal north of Prince Rupert. Existing and proposed linear projects would cover 4,480 ha or 0.6% of the ALR in the Omineca District.

The development of resources presents opportunities for agricultural expansion in the Omineca Region. The additional electrical transmission line along highway 16 and the southern section of the Stikine-Iskut project will clear land and remove forestry as a competing land use. In areas with existing beef ranches, the new right-of-way will add over 1000 AUM (Animal Unit Months) of grazing capacity in the region. In more remote areas, new ranches may be developed to take advantage of the cleared land and improved access. The potential for development of new beef operations in remote areas would be greatly increased by a government plan for orderly agricultural development. Such a plan would include soil and agricultural surveys, market and infrastructure analysis, subdivision and sale of land, etc. In particular, such opportunities may exist along the Cranberry, Kitwanga, Kitsumkalum and Nass Rivers.

The Dome Gas proposal could increase the potential for agricultural development of the Great Beaver Lake-Fort St. James area. The growth in population associated with resource development would increase the demand for locally produced agricultural products. Negative impacts on agriculture from linear development will occur where these projects follow narrow constricted agricultural valley bottoms. The Bulkley and Lower Skeena are examples of potential problem areas.

TABLE 2-15 The Omineca Agricuttural Reporting Region Agricultural Statistics

Population[1]	#	196,116
Farms with sales over 2500[1]	#	1,001
Total Value of Sales[1]	$	29,900,000
Total Land Area[1]	ha	34,843,310
ALR Area[2]	ha	777,483
Arable Land[3] (Improved Class 1-4)	ha	591,247
Improved Farmland[4]	ha	128,973
Irrigated[1]	ha	1,085
Crown Range (Approx.)[4]	ha	3,000,000
Major Crops[1]		
grain	ha	7,539
silage corn	ha	28
forage seed	ha	594
hay	ha	54,061
vegetables and potatoes	ha	198
tree and small fruits	ha	18
Livestock[1]		
beef cattle[5]	#	79,667
dairy cattle[6]	#	5,217
chickens	#	179,048

Source:
1. Census of Agriculture for British Columbia, 1981.
2. British Columbia Agriculture Land Commission, Cumulative Statistics, April 1, 1981. (Agriculture Land Reserve)
3. Canada Land Inventory Classes 1 to 4 inclusive, "improved" as defined in Agricultural Land Capability in British Columbia, B.C.M.A.F. September, 1976.
4. Range Management Branch, B.C. Ministry of Forests.
5. Includes beef; cows, heifers, steers, bulls, and calves.
6. Includes dairy cows and heifers.

TABLE 2-16 The Omineca Agricultural Reporting Region
Linear Development Statistics

	TOTAL		ALR	
RIGHTS OF WAY	km	ha	km	ha
Electrical				
Existing				
500 and 360 kV	770[1]	4,928	320	2,048
2,048				
230 to 287 kV	330	1,386	110	462
Proposed				
500 and 360 kV	1,780	11,392	200	1,280
230 to 287 kV	35	147	0	0
Total	2,915	17,853	630	3,790
Pipeline				
Existing	1,240	1,860	330	495
Proposed	472	708	130	195
Total	1.712	2,568	460	690
MAJOR STATIONS				
Electrical	(#)	(ha)	(#)	(ha)
Existing	6	60	4	40
Proposed	2	20	0	0
Total	8	80	4	40
Pipelines				
Existing	5	50	2	20
Proposed	4	40	0	0
Total	9	90	2	20

TOTALS

	TOTAL	ALR
Right-of-way	20,421ha	4,480ha
Total Land Area	34,843,310ha	777,483ha
% in Rights-of-way	0.06%	0.57%
Stations	70ha	60ha
% in Stations	0.000%	0.008%

[1] Data generated by author, see section 2.1.1 for methodology

[2] Gathering lines registered by the National Energy Board

The Peace Region

The Peace Region contains one third of the arable land and over a third of the cultivated land in British Columbia. The prairie soils of the Peace River area produce 85% of the grain grown in B.C. Grain and oilseed crops are and will probably remain the most important crops in the region. Forage seeds and beef are also important exports. The region is almost self-sufficient in bulk milk but is a net importer of poultry, eggs and vegetables.

Oil and gas development has been the key resource development until the recent development of northeast coal mines. The region is unique in that pipeline rights-of-way far exceed electrical transmission rights-of-way in land area. Another unique feature is the gathering systems centred around Dawson Creek and Fort St. John. These pipelines are smaller in diameter than the transmission pipelines and appear as a separate item in the following table. Most of the proposed linear projects for the Peace Region are gas pipelines. The largest of these are the Foothills Alaska Highway Gas Pipeline and the Dome/Westcoast Gas Pipeline. This picture would change greatly if B.C. Hydro's Liard Hydroelectric Project is undertaken. The project would involve almost 15,000 ha of transmission right-of-way either in the Rocky Mountain Trench or in the Foothills or both.

The direct effect of pipelines on agricultural production in the Peace River Area has not been well researched. Considering the magnitude of the interaction, studies which measure the effect of pipeline on yield and the impact of drilling platforms appear to be justified. If the Liard Hydroelectric project proceeds, possibilities for development of new agricultural land will be opened up by transmission lines, but negative impacts would also occur. The net effect would be positive in the short run if agricultural developments follow right-of-way construction but without careful route selection, transmission lines could impose significant negative impacts in the future. A data gap in the region is the lack of information on the transmission line connecting the Site C hydroelectric generating station to the Williston Substation (Prince George). B.C. Hydro did not include any such proposed link in their potential project list.

TABLE 2-17 The Peace Agricultural Reporting Region Agricultural Statistics: 1981

Background Statistics-1981 Census

PEACE Agricultural Reporting Region

Population[1]	#	55,463
Farms with sales over 2500[1]	#	1,441
Total Value of Sales[1]	$	59,632,000
Total Land Area[1]	ha	19,506,410
ALR Area[2]	ha	1,498,223
Arable Land[3] (Improved Class 1-4)	ha	1,034,999
Improved Farmland[1]	ha	377,232
Irrigated[1]	ha	22
Crown Range (Approx.)[4]	ha	1,000,000
Major Crops[1]		
grain	ha	144,454
silage corn	ha	6
forage seed	ha	13,970
hay	ha	79,428
vegetables and potatoes	ha	31
tree and small fruits	ha	3
Livestock[1]		
beef cattle[5]	#	78,172
dairy cattle[6]	#	3,477
chickens	#	64,281

Source:
1. Census of Agriculture for British Columbia, 1981.
2. British Columbia Agriculture Land Commission, Cumulative Statistics, April 1, 1981. (Agriculture Land Reserve)
3. Canada Land Inventory Classes 1 to 4 inclusive, "improved" as defined in Agricultural Land Capability in British Columbia, B.C.M.A.F. September, 1976.
4. Range Management Branch, B.C. Ministry of Forests.
5. Includes beef; cows, heifers, steers, bulls, and calves.
6. Includes dairy cows and heifers.

TABLE 2-18 The Peace Agricultural Reporting Region Linear Development Statistics

	TOTAL		ALR	
RIGHTS OF WAY	km	ha	km	ha
Electrical				
Existing				
500 and 360 kV	200[1]	1,280	10	64
230 to 287 kV	0	0	0	0
Proposed				
500 and 360 kV	0	0	0	0
230 to 287 kV	0	0	0	0
Total	200	1,280	10	64
Pipeline				
Transmission	870	1,305	125	187
Gathering	970	970	370	370
Proposed	800	1,200	150	225
Total	2,640	3,475	645	785
MAJOR STATIONS				
Electrical	(#)	(ha)	(#)	(ha)
Existing	1	10	0	0
Proposed	0	0	0	0
Total	1	10	0	0
Pipelines				
Existing	8	80	3	30
Proposed	1	10	0	0
Total	9	90	3	30

TOTALS

	TOTAL	ALR
Right-of-way	4,755ha	846ha
Total Land Area	119,506,410ha	1,498,233ha
% in Rights-of-way	0.02%	0.06%
Stations	100ha	30ha
% in Stations	0.007%	0.000%

1 Data generated by author, see section 2.1.1 for methodology
2 Gathering lines registered by the National Energy Board

2.1.3 Highway and Railway Development

Highway and railway systems are well developed in British Columbia. Unlike electrical and gas transmissions, no large scale projects are planned for either highways or railway. Highways and railways are single use corridors. Most of the alienation of land to highways and railways will occur when existing roads are upgraded and existing rail lines, such as the CN mainline, are double tracked. In the case of railways, few economic alternatives exist when an existing route is upgraded.

There are exceptions to this pattern. The Anzac spur to the Northeast coal fields will cross some land used for beef ranching. This line is already under construction. No other major extensions to the existing rail system are planned. If a large scale project such as the BCR Dease Lake Extension is undertaken, a full study of risks and opportunities for agriculture associated with the project should be undertaken.

Several new highways are planned by the Ministry of Highways that will have effects on agriculture. The longest of these is the proposed road between Hope and Kamloops. This road will cross an area of the ALR near Nicola Lake that is important to the ranching industry. The effects of the road on irrigation systems and direct land loss are the most important factors to be considered. Another proposed road that could pass through agricultural land is planned between Nanaimo and Campbell River on Vancouver Island. In addition to crossing the ALR north of Comox, the road could provide a right-of-way which could accommodate a common corridor for future pipelines and electrical transmission lines. Environmental assessment studies of this road are expected to start in 1983. The third major road proposed follows the eastern side of Okanagan Lake, between Oliver and Vernon. The route is similar to that proposed by West Kootenay Power for a 230 kV transmission line. In consideration of the agricultural potential of the area, a common corridor study of the east side of Okanagan Lake may be warranted.

Other major sources of road building are resource companies in forestry, mining, and petroleum exploration. These roads tend to be located in remote areas away from current agricultural development. In the Peace Region, petroleum roads and seismic lines cross many hectares of the ALR. If a resource area continues to develop, the company resource roads are taken over by the government and added to the Provincial highway system. No systematic identification of where these roads will affect agriculture has been made. Major resource roads such as the road through the northern Rocky Mountain Trench being developed by the B.C. Ministry of Forests could open up significant new areas to agricultural development. The survey of land for soils and agricultural capability and the subsequent releasing for sale of agricultural land to qualified operators are of primary importance in areas of resource development. The importance of resource roads to developing agriculture warrants further study.

2.2 Overview of Impacts of Linear Developments on Agriculture

Linear developments such as highways, railways, transmission lines, and pipelines have positive or negative impacts on the natural environment they cross, the people who earn their living and make their life within this environment, and the people who live a distance from the development but are still connected to the development by economic or social ties. Many of these impacts can directly or indirectly affect the agricultural industry.

These impacts can be direct, such as the removal of arable land from production or indirect, such as the growth of market population for agricultural products. Some impacts occur only during construction or during the first few years after construction of a linear project. Others have a long term effect that might not be felt until long after a project is completed.

This relationship between a linear development and agriculture becomes more complex if more than one type of linear development is involved. For example, two electrical transmission lines close together but not adjacent will have a different effect on a farm than if they are adjacent to each other. Similarly, a pipeline and a highway will affect a farm in a different manner than a pipeline only. To further add to this complex relationship, different farms and even different portions of the same farm vary greatly in the crops grown and the techniques used to grow these crops. For example, a given area of a field crop such as peas is much more valuable than the same area of hay. The size of farm machinery also affects the impact of a linear development on a farm. A large harvester will require more clearance around an electrical transmission tower than a small mower.

Over the past twenty years a method of analysis has been developing to systematize the interactions between agriculture and linear development. This system of analysis is especially well developed for electrical transmission lines. The system divides the overall interaction into a series of direct individual impacts to farmers. For example, the loss to a farmer due to weed spread along a linear project is separated from the direct land lost to production. Each individual impact is then analysed as to its cause and value with mitigation and without specific mitigation measures in a wide variety of agricultural situations. This analysis of individual impacts is used in most of the research reviewed in the bibliography section (sec. 2.4) of this report and was also used in the Case Study (sec. 3.0) and Policy Review (sec. 4.0). This form of analysis allows the value of the impact plus the value of a set of mitigation measures to be estimated for a wide variety of agricultural situations before a project is built.

The following section contains a short description of each type of linear project studied and a short review of the major aspects of their construction and operation. Tables reviewing the basic interaction between the type of linear development and different intensities of agriculture are included. Individual impacts are listed in these tables according to stage of linear development activity. Normal mitigation measures are listed for each impact. An X is used to indicate whether the impact is restricted to the right-of-way and to indicate the duration of the impact. Four intensities of agriculture are then listed: cultivated fields, improved pasture, rangeland, and potential farmland. For each of these intensities one of the following ratings is given for each impact: N - negative impact, NS - no significant impact or P - positive impact. These impact ratings are only meant as a general introduction to impact analysis. The actual importance of any impact is very site and time specific. The information for these tables was obtained exclusively from the literature cited in the bibliography section. More detailed information is given in the following sections of this report.

2.2.1 High Voltage Transmission Lines

In British Columbia the major source of electric power is hydroelectric dams. These dams often must be located at distance from load centres (cities and industrial facilities). To tie generation facilities to load centres a provincial extra high voltage electrical transmission grid has been developed. This grid is also connected to neighboring electrical systems. With the increase in electrical demand there has been a progression of larger hydro electric projects that are further from load centres. As a result, longer and higher voltage transmission lines have had to be developed. The long term outlook is for this progression to continue.

Transmission lines are normally divided into categories on the basis of their voltages. As longer distances are crossed, higher voltages must be used to avoid excessive electrical losses. Higher voltage lines require larger towers to maintain adequate separation between lines and ground. At the present time 500 and 230 kilovolt transmission lines are the most common voltages for long range transmission in B.C. If additional generation facilities are developed in northern B.C., 765 and 1000 kV lines may be considered. The basic tower structures used along electrical transmission lines are given in Appendix 3b.

Transmission line development begins with a survey of the centre line. This is followed by logging. Access roads developed during logging may be upgraded for construction use. Prior to actual tower construction, the right-of-way is cleared. In areas where agronomic grass species are desired for grazing, the removal of stumps and roots and seeding with appropriate grasses is normally carried out. Placement of foundations and tower erection is the next step followed by the actual stringing of the conductor. In some cases up to three years is needed to complete this process in an area, although the actual working time is a few months.

Transmission line development has several potential impacts on agriculture, which vary with the intensity of the agricultural practices and the potential for future development. On intensively cropped, irrigated lands, these impacts could be a major obstacle to production. On less intensively cropped lands, such as improved pasture, the impacts may amount only to inconvenience. On lands covered by conifer stands that can be used for grazing, transmission lines can greatly increase the grazing capacity of the land they cross. The presence of transmission lines influences future agricultural development. Their presence discourages high intensity agriculture and encourages low intensity agriculture. The clearing of land and removal of stumps in undeveloped areas have resulted in rapid development of improved pasture and hayfields along the right-of-way.

Table 2-19 summarizes the major electrical transmission line/agriculture interactions. This table indicates that most of the individual impacts of electrical transmission lines on agriculture are either negative or not significant. This does not mean that their overall effect is negative because no numerical values are placed on the impacts listed. Any such values would be very site specific. Further information on these impacts is given in following sections of this report.

TABLE 2-19 Electrical Transmission Lines/Agriculture Interactions

Activity	Impact	Mitigation	Location Right-of-way On	Location Right-of-way Off	Term Long	Term Short	Cultivated Fields	Improved Pasture	Range Land	Potential Farmland
ACCESS	improved farm access,	road upgrading,	-	x	x	-	NS[2]	NS	P	P
	increased traffic,	fence & gates	x	x	x	-	N	N	N	N
	cut fences,	refencing	-	x	-	x	N	N	N	NS
	soil compaction	ripping	-	x	x	-	N	N	N	N
CLEARING	saved expense,		x	-	x	-	NS	NS	P	P
	weed spread	reseeding & spraying	-	x	x	x	N	N	N	NS
CONSTRUCTION	interference with field operations,	timing & notice	x	x	-	x	N	N	NS	NS
	interference with cattle,	timing, notice, fences	-	x	-	x	NS	NS	N	NS
	soil compaction,	ripping & timing	x	-	x	-	N	N	N	NS
	loss of crop	compensation[1]	x	-	x	-	N	N	N	NS
TOWER STRUCTURES	land loss,	tower type	x	-	x	-	N	N	NS	N
	time loss,	route modification	x	-	x	-	N	N	NS	NS
	loss of yield,	tower position	x	-	x	-	N	N	NS	NS
	increased expense,	and orientation	x	-	x	-	N	N	NS	NS
	interference with irrigation		x	x	x	-	N	N	NS	NS
ENERGIZING CONDUCTORS	electric shock,	equipment design,	x	-	x	-	N	N	NS	NS
	accident potential	public education	x	-	x	-	N	N	NS	NS
	restricted development	route modification,	x	-	x	-	N	N	NS	NS

[1] Compensation although often necessary, may not result in any improvement of the impact and may or may not be a form of mitigation. If the compensation is not reinvested in agriculture, it would not be mitigating an agricultural impact only a socio-economic one.

[2] N - negative impact
NS- no significant impact? - unknown
P - positive impact

2.2.2 Pipelines

Pipelines can be categorized in several ways. Gas pipelines carry compressable light gas, normally methane, which is propelled by compressors while crude oil pipelines carry an incompressable fluid that is pumped. This distinction is not as clear for pipelines which carry feedstocks such as ethylene to petrochemical plants. Many of these chemicals have properties which fall between gas and oil. Pipelines are often classified by their diameter with 12 inches being the major division point. Gas pipelines may be high or low pressure, the category separation is at 100 psi. Another differentiation is made between gathering lines in producing areas, distribution lines in consuming areas and the large diameter transmission pipelines that connect them. In spite of these differences a right-of-way of a single, transmission pipeline tends to fall between 12 and 20 m.

Pipelines are normally buried under about 1 m of cover. For this reason rights-of-way normally avoid rocky areas in favor of soil or muskeg. In wet areas construction generally takes place in winter when the ground is frozen. Normally an 18 m wide right-of-way is cleared and a temporary road is constructed. On farm land the topsoil is removed with a small bulldozer to a depth of 0.2 m for a 7 m width and stockpiled. A trench is then dug, and the trench soil piled on the area scraped of topsoil. The pipe is then welded into a continuous length, covered with a protective coating and buried with the trench soil. The stockpiled topsoil is then distributed over the 7 m disturbed area. Revegetation procedures vary with the site and ownership. The entire process can take between 3 and 60 days.

Due to the greater density of oil, oil pipelines are normally routed on flatter land than gas pipelines to avoid the need for very high pumping pressures. This means that oil pipelines have much less flexibility with respect to location.

Pumping stations vary greatly in size with an average station occupying about 3 ha. Some additional area is often used as a buffer strip. Metering stations are placed along pipelines at varying intervals and normally require about 0.5 ha of land. Cathodic inspection posts are located at approximately 2 km intervals. These 10cm by 10cm wooden posts are often located along fence lines.

Table 2-20 summarizes pipeline/agriculture interactions. The majority of farm-pipeline interaction occurs during the construction period. In general the impacts of these interactions are negative. Table 2-20 does not assign any values to these impacts. Impacts on agriculture due to pipelines are generally believed to be less than those due to electrical transmission lines because very few above-ground structures remain to interfere with field operations after construction. Further details on impacts listed in Table 2-20 are given in the following sections of this report.

TABLE 2-20 Pipeline - Agriculture Interactions

Activity	Impact	Mitigation	Location Right-of-way On	Location Right-of-way Off	Term Long	Term Short	Cultivated Fields	Improved Pasture	Range Land	Potential Farmland
ACCESS	improved access,	road upgrading	-	x	x	-	NS[1]	NS	P	NS
	increased traffic,	fence & gates	x	x	x	-	N	N	N	N
	cut fences,	refencing	-	x	-	x	N	N	N	NS
	soil compaction	ripping	-	x	x	-	N	N	N	N
CLEARING	saved expense,		x	-	x	-	NS	NS	P	P
	weed spread	prompt reseeding	-	x	x	x	N	N	N	-
CONSTRUCTION	land loss	prompt construction	x	-	-	x	N	N	N	NS
	cut-off cattle,	bridges	-	x	-	x	N	N	NS	NS
	cut-off irrigation,	temporary pipes	-	x	-	x	N	N	NS	NS
	cut-off drainage,	prompt repair,	-	x	x	-	N	N	NS	NS
	soil compaction,	ripping & timing,	x	-	x	-	N	N	N	N
	soil improvement	de-stoning	x	-	x	-	P	P	P	P
PIPELINE	restricted development,	route modification	x	-	x	-	N	N	NS	NS
	altered drainage,	improved drainage	x	-	x	-	N-P	N-P	N-P	N-P
	potential spills,	contingency plans	-	x	x	-	N	N	N	N
	cathodic corrosion of irrigation pipe	anode field location	x	-	x	-	N	N	NS	N
AUXILIARY FACILITIES	land loss	location	x	-	x	-	N	N	NS	N
GAS TAP-OFF	cheaper energy		-	x	x	-	P	P	NS	P

[1] N - Negative impact
P - Positive impact
NS - No significant impact
N-P -Positive or negative depending on location

2.2.3 Highways

Roads and highways fall into two general categories. Public highways and roads come under the jurisdiction of the Ministry of Transportation and Highways. Private resource roads such as logging roads that are on Crown land are administered by the Ministry of Forests.

Road rights-of-way are single use areas but can be used for communications lines and small gas pipelines and electric transmission lines that are used for local distribution. The width of rights-of-way varies from 20 to 75 metres. In rugged terrain, roads are normally constrained to valley bottoms due to their requirements for grades under 8%.

The direct interaction of roads and agriculture is easy to see. Paved areas completely eliminate other uses although hay is cut on highway rights-of-way in the northern areas of the province. Often the major impact of the highway is not the land lost or gained by agriculture but the socio-economic effects of the increased access developed by the highway. In particular, access to markets, supplies, and support facilities such as schools, and shopping is a necessity for farming communities. The increased urbanization and industrialization often associated with highway development greatly affects agriculture. The increase in local markets can encourage more intensive agriculture such as dairy and vegetable farming.

Highways can have many negative impacts. In well developed areas they don't improve farm access but do increase the pressure for new non-farm development. If existing farms are cut, the resulting pieces may be too small to farm efficiently. Often when a highway cuts through a land parcel the parcel is subdivided along the highway. Farm machinery and cattle have difficulty in crossing a major highway. Improved highways may also increase the competition from imported farm products. Better access can also lead to part time recreation farm development. This type of development can result in the loss of large areas of farmland from commercial production.

TABLE 2-21 Highways - Agriculture Interactions

Activity	Impact	Mitigation	Location Right-of-way On	Location Right-of-way Off	Term Long	Term Short	Cultivated Fields	Improved Pasture	Range Land	Potential Farmland
CONSTRUCTION	land loss	route modification	x	-	x	-	N[1]	N	N	N
	weed spread	clipping & spraying	-	x	x	-	N	N	N	NS
	land fractionation	route modification, crossings	-	x	x	-	N	N	NS	NS
	interference with irrigation	route modification	-	x	x	-	N	N	NS	NS
	interference with cattle	cattle crossings	-	x	x	-	NS	N	NS	NS
OPERATION	greater development pressure	Agricultural Land Reserves	-	x	x	-	N	N	N	N
	improved access,		-	x	x	-	P	P	NS	S
	potential spills	contingency plans	-	x	x	-	N	N	N	N

1 N - Negative impact
P - Positive impact
NS - No significant impact
N-P -Positive or negative depending on location

2 Since roadways are not shared use areas, many of the impacts listed under transmission lines and pipelines do not exist, though land loss is much greater.

Table 2-21 summarizes highway-agricuture interactions. Unlike pipelines where many of the impacts are short-term, highway impacts tend to be long term. Table 2-21 does not assign any values to these impacts. Any such values would greatly depend on the location of the highway. Indirect effects on markets are especially hard to quantify.

2.2.4 Railways

Like highways, railways are single use rights-of-way but are also used as communication lines. The width of the right-of-way for a single track on level ground is approximately 30 m. Railways have the least flexibility in location. They require grades less than 1% and cost over a million dollars a kilometre on relatively level ground. In mountainous terrain the cost of construction can increase tenfold. Construction activities are more intensive for railway than most other linear developments. Construction activities include clearing, earth moving, grading, rock blasting, bridge construction, etc. The direct impacts of railways are similar to those of highways. While the right-of-way is lost to agriculture, it should be remembered that the cheap bulk transport of goods and supplies offered by railways is used by farmers and food processors. This is especially true of grain growing.

Table 2-22 summarizes railway-agriculture interactions. Many of the impacts are similar to those of highways. Often highways require a wider right-of-way than railroads and can therefore result in more land loss. Table 2-22 does not assign any values to the impacts. As with the previous tables, any such values would depend greatly on the location of the railway.

TABLE 2-22 Railway - Agriculture Interactions

			Location Right-of-way		Term					
Activity	Impact	Mitigation	On	Off	Long	Short	Cultivated Fields	Improved Pasture	Range Land	Potential Farmland
CONSTRUCTION	land loss	route modification	x	-	x	-	N	N	N	N
	weed spread	clipping & spraying	-	x	x	-	N	N	N	NS
	land fractionation	route modification	-	x	x	-	N	N	NS	NS
	interference with irrigation	route modification	-	x	x	-	N	N	NS	NS
	interference with cattle	cattle crossings	-	x	x	-	NS	N	N	NS
OPERATION	improved transportation		-	x	x	-	P	P	NS	NS
	potential spill	contingency plans	-	x	x	-	N	N	N	NS
AUXILIARY FACILITIES	land loss	location modification	-	x	x	-	N	N	N	N

1 N - Negative impact
P - Positive impact
NS - No significant impact
N-P -Positive or negative depending on location

2 Since roadways are not shared use areas, many of the impacts listed under transmission lines and pipelines do not exist, though land loss is much greater.

2.2.5 Common Corridors

Various types of linear development are often forced to follow routes that are roughly parallel. In areas of rugged topography, many types of linear projects may be constrained to long narrow valleys. Many linear projects end at a major city. Where these two conditions occur together, such as in the Lower Fraser Valley, over 10 linear projects may run parallel through a narrow valley. It has long been felt that if linear projects could run adjacent to each other in such situations, rather than in separate routes, environmental impacts, including agricultural impacts, could be reduced. The theoretical aspects of this common corridor concept were studied by Ian Hayward and Associates, TERA Environmental Consultants Ltd. and McDaniels Research Ltd. in 1982. This study (Hayward, 1982) contains a list of technical and economic constraints for each project and a table indicating which type of linear projects are compatible. This study concluded that the advantages of the common corridors outweigh the disadvantages in agricultural, suburban and urban areas.

It is extremely hard to estimate the effects of a common corridor policy on agriculture in general. It may be disadvantageous if electrical lines are restricted to land that can be crossed by an oil pipeline. This situation would be detrimental to agriculture because land suitable for oil pipelines would normally have a higher agricultural capability than steeper land which an electrical transmission line could cross. Combined corridors could be advantageous in other situations. The interference with irrigation systems and fractionation of land could be greatly reduced with a common corridor. Table 2-23 summarizes some of the effects which the use of common corridors will have on agricultural impacts when compared to separate corridors on land of similar agricultural potential. A major shortcoming of this type of analysis is that with the exception of the areas immediately around cities, linear projects would normally not be on land with similar agricultural potential. Electrical transmission lines can be located on slopes of

50%. In order to minimize electrical transmission line length, lines are often located on rugged non-agricultural land. Gas pipelines cannot cross land as steep as that which can be crossed by electrical lines but can cross over steeper land than oil pipelines. In general, the cost of avoiding farmland and the technical constraints increase in the following order: electrical transmission, gas transmission, oil transmission, highways, railways.

The following recommendations can be made with regard to common corridors.

1. During corridor selection studies, existing right-of-way should be considered.

2. Multi-discipline common corridor studies should be conducted for several key areas. These areas include the Lower Fraser Valley, southeastern Vancouver Island, the Okanagan Valley and Prince George area.

3. The use of short common corridors in narrow agricultural valleys such as the Bulkley, Pemberton, and Nechako should be studied.

The Case Study of the Sumas-Chilliwack area in section 3.1 of this report reviews the common corridor question in a specific instance.

4. The use of double circuit towers is normally preferable to signle circuit lines.

Table 2-23. Effect of Combined Right-of-Way as compared with Separate Rights-of-Way on Land of Similar Agricultural Potential

Impacts	Electrical Transmission + Pipeline	Highway + Pipeline	Highway + Electrical Transmission	Highway + Pipeline + Electrical Transmission
land loss	little effect[1]	lessened	lessened	lessened
time loss	little effect	little effect	lessened	lessened
weed spread	lessened	lessened	lessened	lessened
soil compaction	little effect	lessened no need for access road	lessened no need for access road	lessened no need for access road
interference with irrigation	lessened	lessened	lessened	lessened
cattle drift	lessened	lessened	lessened	lessened
increased grazing	little effect	little effect	lessened	lessened
recreation traffic	lessened	lessened	lessened	lessened
electrical effects	no effect	no effect	no effect	no effect
clearing	lessened	lessened	lessened	lessened

[1] Based on previous tables and Hayward, (1982).

2.3 Profile of Linear Project Operators

To obtain an understanding of linear developers, their plans, problems and policies toward agriculture, a series of contacts were made with the major linear project operators in B.C. The following is a list of the linear project operators active in B.C. at the present time. All of these companies were contacted.

B.C. Hydro and Power Authority
West Kootenay Power and Light Company Ltd.
Alcan Smelters and Chemicals Ltd.
Westcoast Transmission Company Ltd.
Trans Mountain Pipe Lines
Inland Natural Gas Company Ltd.
B.C. Hydro Gas Division
Foothills Pipelines Ltd.

A questionnaire was used to obtain information. In general, all of the companies were extremely cooperative. The questions were designed to be general and reflect the basic practices of the operators rather than be project or site specific.

A copy of the questionnaire used is included here.

Questions for Linear Project Operators

1.0 Right-of-Way Location

1.1 What are the major factors that determine the location of your rights-of-way?

1.2 What is your policy with regard to location of rights-of-way on farmland?

1.3 What type of station facilities are needed along your right-of-way. How often are these stations needed and what size are they normally?

1.4 Does your company have a policy for common corridors?

2.0 Contact with Farmers and Ranches

2.1 Which department or individual in your firm handles contact with agricultural operators.

2.2 Does your company have regular contact with farm organizations?

2.3 How far in advance of construction are farmers along a proposed right-of-way contacted?

3.0 Construction Phase

3.1 What are the various stages of your linear projects construction and how long does each of these stages normally require?

3.2 Does your company use a standard set of construction guidelines?

3.3 What positive and negative impacts are experienced by farmers during the period of construction?

3.4 Do you have a policy for compensation and/or mitigation for any of the above?

3.5 Do you have a standard right-of-way agreement with farmers along your projects?

3.6 What form of vegetation management is practiced once the linear project is completed?

3.7 Are farmers involved in restorative work in a right-of-way or in the planning of any such work?

4.0 Operation and Maintenance

4.1 What are the positive and negative impacts of your linear project on agriculture once construction is finished?

4.2 How often is ground access needed for maintenance or inspection?

4.3 Does your company normally have ongoing mitigation or compensation or incentive program for farm operators along your rights-of-way?

4.4 Do any of your projects affect farm irrigation or drainage systems?

4.5 Have changes in cattle movements been noticed as a result of the linear projects you have developed.

4.6 In what ways could the relationship between your linear projects and farmers be improved?

4.7 Does your company have any studies regarding the interaction of any of your projects and agriculture?

4.8 Are there particular types of agriculture that can use your rights-of-way better than others?

5.0 Inventory - Current

We would like to obtain the following information on each of your linear projects in B.C.:

5.1 Project name
5.1.1 Size and type of project
5.1.2 width of right-of-way
5.1.3 width and type of structures
5.1.4 location and number of stations along the project
5.1.5 expected life
5.1.6 where, if at all, does this project occupy a common corridor

6.0 Future Project Planned or Anticipated

6.1 project name
6.1.1 size and type of project
6.1.2 width
6.1.3 width and type of structures
6.1.4 location and number of stations along right-of-way
6.1.5 probability of construction
6.1.6 expected in service date
6.1.7 will the project probably follow and use common corridors

A short description of each company, followed by a summary of their responses to the questionnaire is presented here.

2.3.1 Electrical Transmission Lines

a) B.C. Hydro and Power Authority

B.C. Hydro is by far the largest linear project operator in B.C. In 1962 the B.C. Electric company merged with the B.C. Power Commission to form B.C. Hydro. B.C. Hydro services over 90% of B.C. with electricity and gas. B.C. Hydro's installed generating capacity is over 8 million kilovolts, based largely on hydroelectric projects. A publication by B.C. Hydro, Power Perspectives, lists Hydro's integrated transmission system at 31 March, 1981 as the following:

500,000 volt lines	4,017 km
360,000 volt lines	330 km
230,000 volt lines	2,969 km
Total	7,316 km

plus lower voltage lines

Mr. John Kelly, Agricultural and Land Resources Supervisor, Properties Division, B.C. Hydro, acted as contact person for this study. B.C. Hydro supplied the following written response to the linear operators' questionnaire. These responses were received and reviewed at a meeting on November 5, 1982, attended by John Kelly and A.V. Miller, B.C. Hydro's vegetation supervisor. The following is B.C. Hydro's response. Verbal clarifications are given in brackets.

QUESTIONS FOR LINEAR PROJECT OPERATORS

RESPONSE

Statement of qualifications

The term policy as used in the questionnaire, implies a written policy. Many of the answers to questions on policy are, in fact, not written policies but are practices based on extensive experience and having an inherent flexibility that allows application to ever changing situations.

1.0 Right-of-way Location

For both gas and electrical lines the following factors affect location: economic, (engineering, reliability, security), social, environmental, land use - present and future.

Based on these factors, agricultural land is often preferred for the following reasons: ease of access, level topography, low construction costs, better mitigation, compensation and enhancement opportunities, lower operation and maintenance costs.

Gas pipeline station facilities are placed on an "as required" basis. The size also varies although most are less than 0.5 hectares (see attached map). (Largest compressor station occupies 5 ha).

Electrical station types include collector stations and switching stations. Station location and size depend on factors (i.e. line voltage, line location, topography, load centres, etc.) (Capacitor stations are the most frequent and are normally at 280 km intervals).

No common corridor policy exists; however, common corridors are used wherever possible. This factor is considered under Section 1.1.

2.0 Contact with Farmers and Ranchers

The first contact for the acquisition of any rights is prior to the center line survey which usually precedes construction by several years. Public awareness occurs through public meetings, media articles, etc.

3.0 Construction Phase

See appendix 3 for information on construction details. There are essentially no positive impacts during construction other than the ready cash paid for compensation and right-of-way acquisition.

A land owner may experience any or all of the following negative impacts, most of which are temporary and can be mitigated or compensated for: crop damage or loss, field disturbance, noise disturbance, dust disturbance, weed infestation, interruption of equipment operation, soil compaction, cattle loss, damage to fences.

The B.C. Hydro policy is to leave an owner in the same position after the activity as before as far as restoration and monetary compensation can do so. Land disturbance is restored and mitigated. Damages to improvements are compensated for. Land acquired is done so at fair market value.

On crown land, rights-of-way are reseeded to stabilize the soil and then natural vegetation is allowed to generate. Undesirable species are controlled. Regional staff may seed areas based on adjacent land use, i.e., rangeland may be seeded to grazing tolerant species so that the right-of-way can be included in the range unit. In general it depends on the wishes of the farm community.

4.0 Operation and Maintenance

4.1 Private property

Positive

A landowner may receive one or all of the following positive impacts: additional cleared land for cultivated crops or pasture land, new access, new fencing or replacement of existing fences, all fences and improvements grounded, cattleguards or gates, farm roads improved. A landowner will not receive any negative impacts from a gas line if proper mitigation and enhancement applied.

Rangelands may be improved by one or all of the following: fencing along right-of-way allows for improved herd management, seeded rights-of-way provide additional forage.

Negative

A landowner along an electrical right-of-way may experience one or all of the following negative impacts: disruption to cultivation, interference with irrigation (present and future), electrical shocks, weed infestation around towers.

Rangeland may be adversely impacted by: removal of natural cattle barriers, weed infestation (possibly noxious) if reseeded rights-of-way are overused by cattle.

Measures such as the following are designed to minimize the encumbrance of electrical transmission facilities on agriculture: extending tower length (also allows extending the distance between towers), use property boundary lines rather than crossing the middle of a field, match stepping towers, selecting towers that take up the least amount of land.

Cattle activity on rangeland has changed as cattle gravitate to the more desirable species planted on rights-of-way. Corrective measures are often taken. Also, the removal of natural barriers allows changes in herd movements.

b) West Kootenay Power and Light Company Ltd.

West Kootenay Power and Light Company Ltd. provides hydroelectric power for the southeastern corner of the province of B.C. from the east side of Okanagan Lake to Creston. West Kootenay manages five hydro-electric plants for Cominco Ltd. Mr. Lorne E. Trickey, P.Eng., Assistant Manager, Transmission and Distribution, was interviewed at the company's offices, Waneta Plaza, Trail, B.C., on October 7, 1982.

Answers to Linear Operators Questionnaire:

1.0 Right of Way Location

West Kootenay avoids creating new rights-of-way, normally existing rights-of-way would be upgraded to meet increased demand.

In the past, economic factors were paramount in location of rights-of-way. Last new right-of-way was established in 1964. If a new line were being designed, farmland and other environmental factors would be considered.

No new substation facilities are foreseen except for a tie with B.C. Hydro at Oliver. Some upgrading of existing substations may be needed.

2.0 Contact with Farmers

Transmission personnel in local offices handle all contact with farmers.

3.0 Construction Phase

Survey, selective clearing of tall vegetation, tower placement, erection and rigging. Process can be completed in a few months (230 kV). Standard structural designs are used. Major impact on automated irrigation system has resulted in one line being moved at farmer's expense. It is West Kootenay's policy to negotiate right-of-way agreements and not to expropriate. The system has only had a single expropriation. A single lump sum payment for a reasonable compensation is the only compensation given. Little vegetation management is practised. About four times a year rights-of-way are inspected and taller trees removed. Herbicides are not used for clearing. A soil sediment is sometimes used to prevent fire damage to poles. Farmers have seeded rights-of-way to grass.

4.0 Operation and Maintenance

The following impacts have occurred along West Kootenay's rights-of-way; transmission towers have blocked automated irrigation systems, some cattle drift along right-of-way has been experienced. Fences are built by West Kootenay as needed. Towers have interfered with farming operations.

c) ALCAN Smelters and Chemicals Ltd.

The Alcan hydro-electric plant at Kemano came into operation in 1954. Using a dam on the Nechako River, water was impounded in a lake chain extending through Tweedsmuir Park, then diverted through a 16 km tunnel at Kemano. A 50 mile, 287 kV transmission line connects the 812 MW generators at Kemano to the aluminum smelter at Kitimat. Mr. J.W.L. Duncan, Manager, B.C. Power Operations, ALCAN Smelters and Chemicals Ltd. responded in writing to the Linear Operators' Questionnaire.

1.0 Right-of-way Location

Cost and security from natural hazards are the major factors determining right-of-way location.

2.0 Contact with Farmers and Ranchers

Not applicable to date

3.0 Construction Phase

To date we have not affected a project which fell under the linear project guidelines. Any of our past projects would not have affected agricultural land. Rights-of-way are kept clear. At the present time there are no farming areas along the right-of-way.

4.0 Operation and Maintenance

There is no agriculture or farming in the area.

2.3.2 Pipelines

a) Westcoast Transmission Company Ltd.

Nearly all of the natural gas from B.C. wells is purchased by the B.C. government through the B.C. Petroleum Corporation. The Petroleum Corporation then sells the gas to Westcoast which is responsible for gathering, processing and selling the gas. Westcoast also buys gas from Alberta, the Yukon and Northwest Territories. Westcoast's major customers are B.C. Hydro, Gas division, Inland Natural Gas and Pacific Northern Gas which is itself a Westcoast subsidiary. A large fraction of Westcoast's gas is sold to the U.S.

Mr. Bernie Guichon, Manager, Lands, Right-of-Way and Environment Division of Westcoast Transmission Co. Ltd. was interviewed in Vancouver on October 21. In addition to the following responses to the questionnaire, Mr. Guichon supplied Westcoast's Right-of-Way Agreement, Environmental Procedures Manual, and Damage Policies, and System Map. Mr. Guichon also gave additional information based on his long experience with pipelines and ranching. The following are Mr. Guichon's responses to the Questionnaire:

1. Right-of-Way Location

> The major factors in locating our rights-of-way are topography and finding suitable material in which to bury the pipeline. Land ownership, agricultural development, or capability is only a minor consideration. Indian Reserves are normally avoided.
>
> Problems are encountered with both Crown Land and private land. Discussions are held with farm operators along a proposed right-of-way. Routes are modified to take into account farmers' preferences where this is possible.

Compressor and booster stations are located at varying spacing along the line. Stations are necessary where lines meet. Normally locations can vary a kilometre in either direction from engineers' specifications. Compressor stations normally occupy 40-80 acres although much of this is an environmental buffer strip. This strip could be used for farming. Access is a consideration in locating compressors. Metering stations occupy about 1 acre and occur more frequently along a line than compressors. Catalytic inspection posts are small and are normally placed on fence lines.

Westcoast prefers to share corridors with affiliated companies. A single company, normally Westcoast, is solely responsible for the right-of-way. (Affiliates include Westcoast Petroleum Ltd., Pacific Northern Gas Ltd., Saratoga Processing Company Ltd., Westcoast Transmission (Alberta) Ltd., and Foothills Pipelines (North B.C.) Ltd.

2.0 Contact with Farms and Ranches

Regional Managers located at 25 locations in B.C. handle contacts with agricultural operators along their sections of rights-of-way. Land owners along the Right-of-way are given calendars each year which give regional managers' names and numbers and emergency procedures.

2.2 Westcoast responds to enquiries made by farm organizations but does not maintain continuing liaison.

2.3 Farmers along a proposed right-of-way are contacted well in advance of construction (over 1 year). Line location can be modified in some cases. Needs for temporary fencing, irrigation equipment and plugs (small earth bridges across the trench) are decided before construction to prevent cutting off cattle or water.

3.0 Construction Phase

The major construction steps in pipelines are establishment of a temporary access road, stripping and stockpiling topsoil, trenching, pipe welding and coating, laying the pipe, backfilling the trench, and replacing topsoil. The entire process normally takes one month. Three days is an absolute minimum in special areas.

Westcoast uses its Procedures Manual for Environmental Engineering. This manual is constantly updated. (Westcoast supplied the October, 1981, edition). The following topsoil and removal replacement sequence drawing will be included in the next edition.

The major negative impact during the construction period are caused by human errors made in replacing fences and constructing temporary gates. Farmers are compensated for all damage caused during construction.

On Crown Land there is an aerial seeding program once construction is finished. On private land the landowner is compensated for re-establishment of the desired vegetation.

4.0 Operation and Maintenance

The presence of a pipeline restricts what developments are allowed on a right-of-way. No foundations are permitted but the right-of-way can be used as a parking lot, etc. In general, pipelines are felt to have few ongoing effects on agriculture. Recreational use can be a problem. Westcoast Transmission places the following advertisement in local newspapers to discourage the use:

Information Services use only:

INFORMATION SERVICES

ADVERTISING INSERTION INSTRUCTIONS

INSTRUCTION DATE: 82-01-15

PUBLICATION(S): See Below

INSERTION DATE(S): A.S.A.P.

SPECIAL INSTRUCTIONS: See Below

CHARGE TO: 685-14-074

APPROVAL: (Division Manager)

APPROVAL: (Personnel Supervisor)

COPY:

ATTENTION

SNOWMOBILERS TRAIL BIKE RIDERS 4x4 OPERATORS

Westcoast's pipeline right-of-way crosses PRIVATE as well as CROWN property. Westcoast does not own the right-of-way and has only the right of entry for operational and maintenance duties.

Please DO NOT ENTER OR UTILIZE the right-of-way without the permission of the landowner, or in the case of Crown land, the applicable Government Agency, i.e. Forest Service, Lands Service and/or Fish & Wildlife Service.

WESTCOAST
TRANSMISSION
COMPANY LIMITED

PRINCE GEORGE CITIZEN
QUESNEL CARIBOO OBSERVER
MERRITT HERALD
WILLIAMS LAKE TRIBUNE
100 M. HOUSE FREE PRESS
KAMLOOPS NORTHERN SENT
HOPE STANDARD
CHETWYND ECHO
FORT ST. JOHN-ALASKA HWY. NEWS
FORT NELSON NEWS
DAWSON CREEK-PEACE RIVER BLOCK NEWS

FORM 151 (Revised June/78)

Pipeline routes are inspected by helicopter annually, and after each major storm. Cathodic inspections are made approximately once a year. A new development is the "smart pig", a device that inspects the pipeline from inside while being transported in the pipeline.

If problems develop for a farmer as a result of an existing pipeline, Westcoast will normally pay for the needed mitigation even though not legally bound to do so.*

The only effect on irrigation found is with flood irrigation. In some situations water will not cross a new pipeline, but will be channeled into the ground. Normally this problem lasts only until a sod has developed. Compensation is paid for lost yield in the meantime.

During construction, drain lines may have to be cut. If this is done, a solid pipe is installed between the cut ends. Before this is done, the pipeline is cleaned of soil and debris.

Two problems have been noted with cattle movement. The most important is vandalism, especially by recreation vehicles using the right-of-way. Some worry has been expressed with regard to overconcentration of cattle on the right-of-way. No studies are known on the subject. Mr. Guichon suggested putting unpalatable grasses into vegetation seed mixtures to mitigate this problem.

A very good relationship already exists between farmers and Westcoast.

Danny Grant of Interwest Property Services Ltd. has been commissioned to provide a report on land acquisition costs for pipeline rights-of-way. A copy will be made available when this study is completed.

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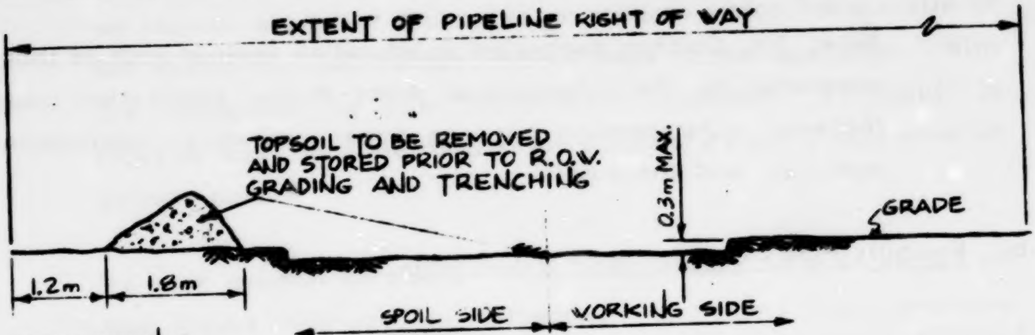
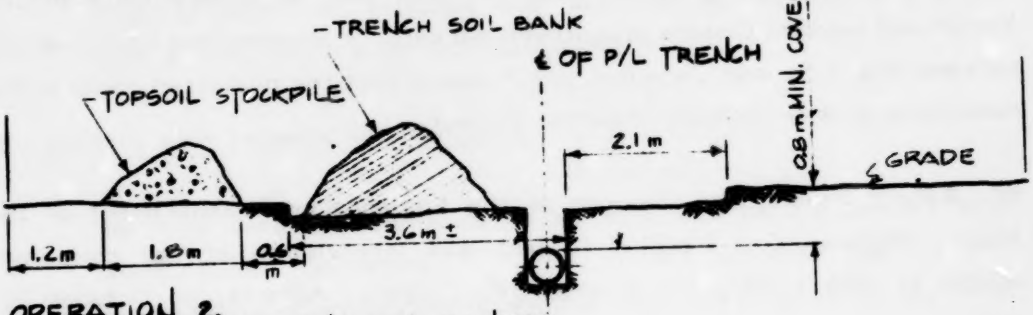
* The NEB Act appears to require such procedure, see section 4.

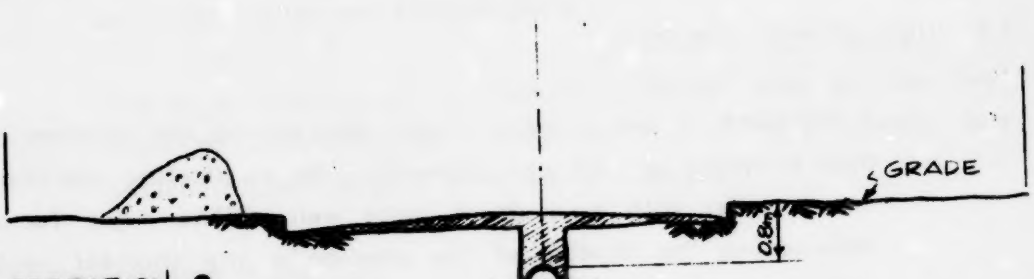
TOP SOIL REMOVAL AND REPLACEMENT SEQUENCE


EXTENT OF PIPELINE RIGHT OF WAY
TOPSOIL TO BE REMOVED AND STORED PRIOR TO R.O.W. GRADING AND TRENCHING
0.3m MAX.
GRADE
1.2m
1.8m
SPOIL SIDE
WORKING SIDE

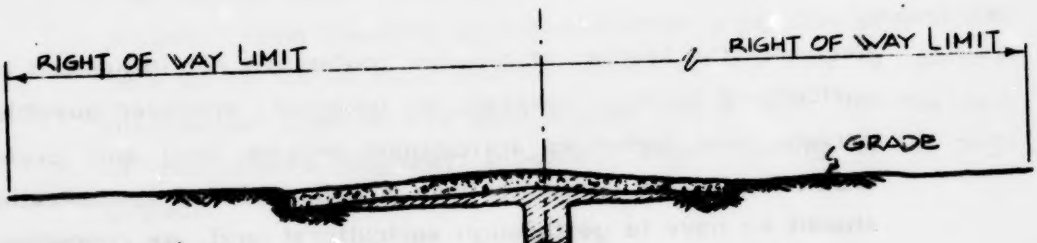
OPERATION 1.
TOP SOIL STOCK PILING


TRENCH SOIL BANK
℄ OF P/L TRENCH
TOPSOIL STOCKPILE
0.8m MIN. COVER
2.1m
GRADE
1.2m
1.8m
0.6 m
3.6m ±

OPERATION 2.
TRENCH EXCAVATED AND SOIL BANKED



OPERATION 3.
PIPE TRENCH BACKFILLED


RIGHT OF WAY LIMIT
RIGHT OF WAY LIMIT
GRADE

OPERATION 4.
TOP SOIL REPLACED

Virtually all forms of agriculture are felt to be compatible with pipelines.

Note: Mr. Guichon suggested an education seminar such as those sponsored by the International Right-of-Way Association could increase understanding between linear operators, government agencies, and the public.

b) Foothills Pipelines (Northern B.C.) Ltd.

Foothills Pipelines is the principal in the project to construct a large diameter natural gas pipeline from Prudhoe Bay in Alaska through the Yukon and western Canada to southern markets. Agreement has been reached between the U.S. and Canadian governments that the preferred route is the company's Alaska Highway Pipeline Project.

Mr. Robert Owens, the Manager of the Environmental Department of the Alaska Highway Gas Pipeline Project was interviewed at the company's offices at 1600 - 205 - 5th Avenue SW, Calgary, Alberta, on October 20, 1982.

1.0 Right-of-way Location

Agriculture is not a major focus determining the location of high pressure natural gas pipelines. We as pipeline operators can co-exist with agriculture quite well. The major factor determining the location of the pipeline is the shortest route with the least geotechnical problems. Generally that means away from rocks and away from the wet.

Generally the location of pipeline routes are not influenced by agricultural lands. However, we do avoid, wherever possible, private land including agricultural private land and prefer crown land. We generally have a policy of full compensation should we have to go through agricultural land, we compensate for loss of forage, reseed to the standard the farmer requests or compensate the farmer to reseed to whatever product he requires.

Compressor stations vary in size and their spacing varies as well. For the B.C. section of the Alaska Highway gas pipeline we require a total of 9 compressor stations which have a size of 600 metres by 1000 metres [60ha], once in full operation. With the exception of the compressor stations, all land is right-of-way, only the compressor stations are purchased when in private land.

We seek common corridors which is expressed in the concept of the Alaska Highway gas pipeline. However, high pressure pipelines need at least 100 metres from the highway right-of-way. We consider the fact that access exists a major cost saving feature for our gas pipeline.

2.0 Contact with farmers and ranchers

We have various individuals in our firm who handle contact with agricultural operators. The first person to contact agricultural operators for planning and construction is the land man, who, during construction, is followed by the field environmentalist and field engineer.

The legal requirement to contact a farmer with private land prior to imposition of a right-of-way is one month, but generally Foothills give more notice than that.

3.0 Construction Phase

The various stages of linear projects vary with the size of the project. From planning to implementation a pipeline project can take up to six to eight years. However, the rule for general distribution lines is less than a year and a half. In the case of the Alaska Highway pipeline, we're looking at a mega project.

We don't have a standard set of construction guidelines but for your reference we would like to give you the Environmental Plans and Procedures Manual we have developed for a northern Saskatchewan project which is very similar to the B.C. portion and for B.C. we would develop a similar document. This Environmental Procedures Manual is then put into the drawings and specs for tender documents for the construction contractors.

Generally there is a slight negative impact on the farming community during the construction and operation of a gas pipeline. The major negative impact is during construction in that it disrupts farming activity and loss of crops. We have a policy of full compensation for that impact. Sometimes slight improvements in productivity after construction can be found in case we sculpture, remove stones, fertilize and seed the right-of-way to full crops.

We have a policy of full compensation and/or mitigation for private farm operations.

4.0 Operation and Maintenance

The small loss of productivity during operation can sometimes be mitigated by more intensive agricultural practices which we will encourage.

The line is walked only when needed. However, air inspection takes place at least once a week. Generally the pipes are inspected for leakage and during this inspection any environmental problems will be noted.

We don't like extremely heavy equipment on top of our pipe or large digging equipment.

c) Inland Natural Gas Company Limited

Inland is a natural gas transmission and distribution company serving the North Central Cariboo, Okanagan, and Kootenay areas of B.C. Gas is purchased from Westcoast Transmission. Inland's system included about 18 kilometres of transmission pipeline.

Mr. Jon Barker, Supervisor of Transmission, was interviewed at the company's offices at 1066 West Hastings, Vancouver, on October 27, 1982.

Answers to Linear Operators' Questionnaire are as follows:

1.0 Right-of-way Location

Inland chooses the shortest route with the least geotechnical problems and go through farmland. Inland has only three compressor stations in British Columbia.

2.0 Contact with Farmers and Ranchers

Inland's land supervisor contacts all owners of land and agricultural land.

Generally farmers are contacted 6 to 12 months in advance of construction and there is ongoing contact with farmers who have easement.

3.0 Construction Phase

Generally Inland follows the regulatory process. However, most of our projects are small and are not regulated.

Engineering specs based on the CSA code Z184 are used for construction.

Positive impacts are the fact that the land is improved by grading, aerating, and saving all topsoil. The negative effect is the interruption to the growing season. Inland avoids any potential interruption by constructing during the non growing season.

Inland compensates all farmers.

Inland generally reseeds and prefers that the farmer does it himself and we pay cost.

4.0 Operation and Maintenance

The positive impacts during the operation of a high pressure gas system are the land improvement and productivity improvements. The negative impacts are weed infestations. For the latter we give the landowner the herbicide he needs and he applies it at his cost. In Crown land we have an agreement with the Ministry of Forests and/or Agriculture and participate on a per acre basis for knapweed eradication programs. Another impact Inland has observed is where our anode beds are close to agricultural irrigation systems, the aluminum pipes can oxidize quickly. Inland therefore has a policy to keep our anode beds (spaced every 20 to 50 miles) away from agricultural lands. An additional impact observed is that a surveyor's stakes along property lines which are 3/4 of an inch thick and three feet deep can sometimes puncture our high pressure system and cause damage therefore. Another negative impact we have observed is orchards and vineyards which require staking where mechanized augers may puncture our lines.

Inland walks the line once a year and do aerial surveys where we can't walk. Aerial surveys are done twice a year.

Only where drainage ditches have to be dug does the landowner require a permit. He contacts the B.C. Ministry of Transportation and Highways for approval. The pipeline branch then contacts us and we approve the line location.

Inland needs to improve their relationship with farmers.

d) Trans Mountain Pipe Line Company Ltd.

Trans Mountain owns and operates a pipeline for transmission of crude oil and natural gas liquids from Edmonton to Burnaby, British Columbia. The length of the system is 715 miles with a capacity of 410,000 bbls/day.

Mr. E. Wildeman, Land and Rights-of-way Agent and W.F. Culling, assistant, were interviewed at the company's Vancouver office on October 28, 1982.

Answers to Linear Operators' Questionnaire are as follows:

1.0 Right-of-way Location

The shortest distance and lowest grade determine the routing of an oil pipeline. In addition, we require a suitable overburden to bury the pipe.

Generally private lands and farmlands are avoided.

At present Trans Mountain has ten pump stations in B.C. In addition, we require tank farms, relief stations and pipeline terminal facilities in British Columbia.

Trans Mountain has no policy for common corridors but looks favorably on sharing a common corridor.

2.0 Contact with Farmers and Ranches

Lands and Rights-of-way agent deals with agriculture operators. Weekly helicopter patrols are made over our pipeline system and the pipeline is walked at least once a year. In addition, an annual news letter goes to all farm operations affected by our pipeline system.

Generally farmers are informed one to two years in advance of construction.

3.0 Construction Phase

Trans Mountain is regulated by the National Energy Board and it takes a number of years to plan, regulate and construct a pipeline.

The positive impacts of construction are generally the grading, contouring, and improvement of drainage along and adjacent to the right-of-way. The negative aspects are the temporary disturbance and the crop loss.

Trans Mountain is required to keep our right-of-way clear from timber and high bush, however, grasses and crops are encouraged. The main determinant is to be able to aerially inspect the buried pipe.

A farmer can be requesting the type of restorative work he wishes to see. He can either do it himself and we pay him, or else we can do it for him.

4.0 Operation and Maintenance

The long term effects of operation of a right-of-way across a farmer's land is generally positive. We bend over backwards to make the land as suitable for farming as possible.

Should the farmer wish to develop an irrigation system or drainage system, proof of depth is required before he can ditch across the pipeline right-of-way. This involves a team going out and exposing the pipe to prove depth of cover. Trans Mountain then works out a suitable drainage system with the farmer.

2.4 Highlights from Annotated Bibliography

As part of the inventory of linear projects and agriculture, an annotated bibliography was prepared. This bibliography is presented in Appendix 4. The following are some highlights from the annotated bibliography. All literature cited in the annotated bibliography is listed in the bibliography at the end of the main volume. Several types of publications wre reviewed but the emphasis was placed on scientific studies in which original data was generated. The annotated bibliography is divided into the following categories:

Electrical Effects
Socio-economic Effects
Land Value Effects
Public Informatin Booklets
Other Studies

For each of these categories, one reference has been chosen that best represents the other entries in that category.

Electrical Effects

Author (date): Miller, M.W., Kaufman, G.E., (1978).

Title: High Voltage Overhead

Publisher: Environment Magazine, Vol. 20, No. 1.

Subject: Electrostatic and Electro-magnetic Effects

pp.: 6-36

Summary:

Miller and Kaufman conclude that neither animal and plant experimentation nor clinical studies nor 25 years experience with operating EHV transmission lines have to date provided convincing evidence for a harmful effect of exposure to electric and magnetic fields associated with transmission lines, in spite of numerous attempts to find such effects. Likewise, on a biophysical basis one would have no reason to expect there to be effects. Thus, while one can never prove the negative (i.e., that there is no effect), the overwhelming body of scientific evidence indicates that electric and magnetic fields associated with high voltage transmission lines have no deleterious biological effects.

Current plans for future higher voltage transmission lines appear to limit maximum ground level electric fields to approximately the 10 kV/m level. Miller and Kaufman believe this is prudent. Above about 10-12 kV/m the possibility of "annoyance" shocks becomes greater and in a "worst case" situation a dangerous "no-let-go" incident of a child holding onto a large vehicle could be imagined. Also, above 15 kV/m some people may find the skin sensation annoying. Therefore, while there does not appear to be any serious risk from the direct biological effects of electric or magnetic fields generated by future transmission lines operating at higher voltages, if future designs call for gradients much in excess of 10 kV/m we would suggest that a serious risk-benefit assesssment should be undertaken.

Socio-economic Effects

Author: McKinnon, Allen and Associates (Western) Ltd. (1978)

Title: The Cost of Farming Around Transmission Line Towers in Central Alberta

Publisher: Calgary Power Ltd.

Subject: Cost of Farming around transmission towers.

Summary: The purpose of the study is to determine economic effects of towers on yields of crops, equipment efficiency, chemical efficiency, risk and management. The study methods included farm surveys, farm operator interviews, aerial surveys, video taping of farm equipment operations around towers, in-the-field measurements, and analysis of crop yield variance around towers. The study area included Calgary north to Benalto along a twin line and Calgary north to Red Deer along a single line. Twenty-five farm operations were chosen for surveys and interviews.

From the interviews the following came t6 light:

Farmers who had machinery collide with towers	33%
Average down-time per collision	2.6hr
Farmers who thought yields around towers were reduced	87%
Farmers who thought weeds were a problem in and around towers	70%
Average number of machine operations each year	
- on cultivated cropland	10.74
- on summerfallow	5.6
- on hayfields	4.98

Average revenue per arable acre in the study area is $99.85

From machinery observations and measurements, there are two main methods of pulling implements around a tower. The "complex" method means driving to either side of the tower leaving a diamond area not worked. The extra time and cost involved for equipment for the "complex" and "diamond" methods are shown in the following tabulation.

COST PER TOWER PER YEAR TO FARM AROUND SINGLE AND DOUBLE TOWERS AS PRESENTLY PLACED

	Single Tower		Double Tower	
	"Complex" Method	"Diamond" Method	"Complex" Method	"Diamond" Method
Weed control	$11.00	$11.00	$11.00	$11.00
Herbicide misses	.29	.29	.61	.61
Harvesting loss	.34	.34	.34	.34
Double seeding effect	.81	.21	.81	.32
Extra machine operation	3.47	2.86	3.47	2.86
Area lost to production	1.90	2.57	1.90	2.57
Risk of Bertha Army Worm	.72	.72	.76	.76
Time loss due to collision	9.87	9.87	9.87	9.87
Collision repair insurance	4.98	4.98	4.98	4.98
Annual cost	$33.38	$32.95	$33.74	$33.31

The twin line increased the cost slightly per tower.

The farmers interviewed were not united in their opinion, but in the case of a twin line, most preferred the towers opposite each other as opposed to staggered.

There are other operating situations around towers which are variable in nature and occur less frequently. Allowances for the costs of these situations have not been included in the above tabulation. For example, in one case where the tower was too close to the fence to get equipment through, the extra cost was $1.45 per tower for lost crop due to missed areas of herbicide.

Towers would be less of a problem if placed on a fence line. The cost in this situation is estimated to be as follows:

COST PER TOWER PER YEAR TO FARM AROUND TOWERS STRADDLING FENCE LINES

Extra machinery operation	$ 2.24*
Double seeding	.32
Weed control	11.00
Herbicide miss	--
Area lost to production	2.06
Harvesting loss	--
Time loss due to collision	8.00*
Insurance for collision repairs	4.98*
Bertha Army Worm control	.68
	$29.28

* Swathing the outside round backwards with a self-propelled swather and combining the round backwards would substantially decrease the extra machine time required and also reduce the risk of collision.

Appendix 4c Land Value Effects

Author: Delotte, Haskins and Sells Associates (1980).

Title: The Effect of Pipeline Installations on Agricultural Land Values in Alberta.

Publisher: Delotte, Haskins and Sells Associates.

Subject: A Study of the Effects of Pipeline Installations on Agricultural Land Values in Alberta.

pp: 59

Summary: The study was conceived and completed to determine "The Effect of Pipeline Installations on Agricultural Land Values in Alberta". The objectives of the study were:

- to determine what effect, if any, a pipeline has on the market value of agricultural property,
- to identify related factors which may influence a potential change in agricultural land values, and
- to determine study areas which may have different land value changes due to pipelines.

Study findings indicate that pipelines have no effect on agricultural land values. That is, the presence of a pipeline on a parcel of land does not cause market participants to devalue or discount the total land value. For all seven study regions and in all study cases but one, no significant differences (at the 95% confidence level) were found in the average price per acre between lands with and without pipelines. This finding was consistent for both soil classes and for both sizes of land parcels studied (quarters and greater than 170 acres).

In this study, relaxing the confidence level to 80 or 90 percent would have minimal effect on the results or the conclusions that pipelines have no effect on the market value of agricultural lands.

Public Information Booklets

Author: Ontario Hydro (No date)
Title: Working under Extra High Voltage Lines

Publisher: Ontario Hydro

Subject: Public Information Booklet

pp: 16

Summary: Designed for people who work near 500 kV lines, the pamphlet covers the following:

- electrostatic charges (shocks)
- charges on vehicles
- clearances (20 feet from line under 129 feet tall)
- refuelling
- building
- wire fences
- electric fences
- irrigation systems
- fires
- lightning
- ozone
- television and radio reception
- electromagnetic fields
- noise
- explosions and the Esso Demonstration centre

Other Studies

Author: Westcoast Transmission Company Limited (1981).

Title: Procedures Manual for Environmental Engineering Revised Oct. 1981.

Publisher: Westcoast Transmission Company Ltd.

Subject: Outlines Construction and environmental mitigation measures used by Westcoast and related companies during pipeline construction.

pp: 53

Summary: An environmental procedures manual that is used as an information document for use by company personnel in designing, instructing and maintaining pipeline systems in B.C. The manual is also used to provide a set of standard methods which is used by consultants and government agencies in reviewing pipeline proposals and monitoring field activities.

The manual describes procedures routinely followed by Westcoast, and summarizes the complex regulatory requirements which apply to gas pipelines systems. Procedures are discussed in the normal sequence of activities, followed by a summary of environmental legislation. These are Planning and Design, Construction, Operation and Maintenance, and Abandonment. The last section describes current environmental legislation.

The manual is a "current state of the art" document and is regularly updated.

3.0 PHASE II - CASE STUDIES

Two case studies were undertaken to gain a practical appreciation of the interaction of linear developments and agriculture. Two widely varying situations were chosen.

The first study was in the Lower Fraser Valley. The first study area consisted of a 7 kilometre long by 2 kilometre wide strip between Sumas and Chilliwack. This strip contains 2 gas pipelines in a shared right-of-way, three electrical transmission lines in one shared right-of-way, the B.C. Electric Railway, and a short section of the Trans Mountain Pipe Lines Ltd. crude oil pipeline. The area is primarily used for dairy production. The linear developments were found to have mainly negative impacts in this area. These impacts were assessed quantitatively where possible. The effectiveness of mitigation measures was evaluated as was the potential effectiveness of mitigation measures that could have been, but were not used. The use of common corridors in this area was also evaluated.

The second case study was located in a ranching area just north of Williams Lake. The area is a 2 kilometre wide strip 10 kilometres long, following the Williston-Kelly Lake Transmission Lines between Williams Lake Creek and Hawks Creek. This area is used by several ranches for grazing. The electrical transmission line in this case study was found to have a net positive effect on agriculture. Several negative impacts were found and mitigation measures recommended to reduce these.

The first case study approximates a worst case situation. A prime agricultural valley adjacent to a major market is confined by mountains through which a number of linear developments pass. The second case study represents a much more positive situation. It is an extensive plateau which would be used for improved pasture for beef production were it not for the high cost of land clearing. Taken together these two case studies represent a wide range of interaction that takes place between agriculture and linear projects. The evaluation made in these case studies is applicable to a wide range of the linear projects proposed for British Columbia. Section 3.3 gives general conclusions that can be drawn from these case studies. Recommendations are made for areas for further study. These include specific interactions which could not be evaluated within the scope and timing of the study and interactions which are not covered in either case study.

3.1 Case Study 1 - Sumas Valley

3.1.1 Background

Physiography

The first case study was located in the Sumas Valley of the Lower Mainland. This valley is bounded on the north by Sumas Mountain and on the south by Vedder Mountain. Both of these mountains rise from near sea level at their base to over 900 metres in elevation in a horizontal distance of 2 kilometres. Thus these steeply sloping mountains force most linear developments onto the flat valley bottom. This extremely flat valley bottom is 6 kilometres wide and is the floor of a glacial lake. Figure 3-1 is a location map of the Sumas Valley, showing the study area and the location of the linear developments that follow the Sumas Valley.

The study area is a 2 kilometre wide strip, 7 kilometres long that follows both the B.C. Hydro and Westcoast Transmission rights-of-way. Figure 3-2 is a study area map using an air photo mosaic as a base. The map shows the location of farms and fields, roads and waterways. A soils map based on Luttmerding[1] (1980) has been superimposed on the air photo along with specific information on linear developments and location of field inspections. Land capability for agriculture ratings were made for the study area based on a 1:50,000 agricultural capability manuscript map supplied by the B.C. Ministry of Environment. Assessment of the improvements to the agricultural capability that would result from irrigation and drainage were estimated by the author.

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[1] Luttmerding, H.A., 1980, Soils of the Langley Vancouver Map Area, Report 15, B.C. Soil Survey, Ministry of Environment, Kelowna, B.C.

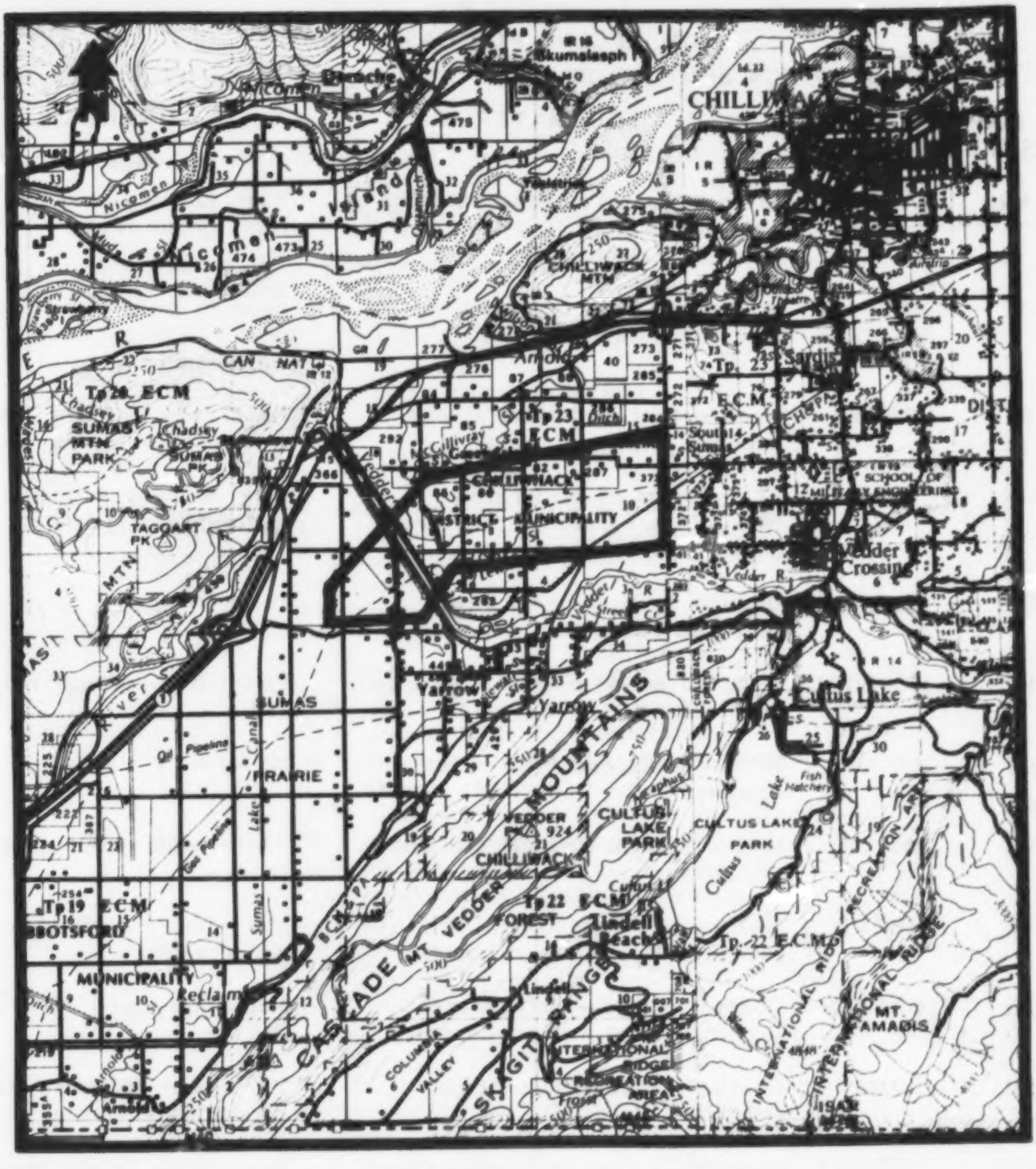

CHILLIWACK
Sardis
Vedder Crossing
Cultus Lake
CULTUS LAKE PARK
Yarrow
SUMAS PRAIRIE
SUMAS MTN PARK
TAGGART PK
Tp 20 ECM
Tp 23 ECM
Tp 22 ECM
Tp 19 ECM
CHILLIWACK DISTRICT MUNICIPALITY
ABBOTSFORD MUNICIPALITY
VEDDER MOUNTAINS
CHILLIWACK FOREST
CASCADE
SKAGIT RANGE
INTERNATIONAL RIDGE RECREATION AREA
MT. AMADIS
Lindell Beach
COLUMBIA VALLEY
Vedder Canal
Nicomen
Skumalasph
CHILLIWACK MTN
SCHOOL OF MILITARY ENGINEERING
Fish Hatchery
Vedder R.
Sumas River
Oil Pipeline

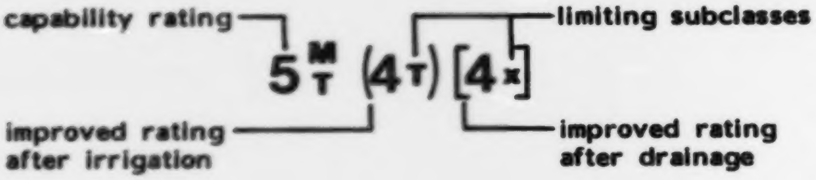
Figure 3-1 Case Study Site #1 Location Map

Scale 1:125,000

SOIL LEGEND FOR CASE STUDY #1

MAP SYMBOL	SOIL NAME	SOIL MATERIAL	DRAINAGE
AN	ANNIS	15 to 40 cm of organic material over moderately fine textured floodplain deposits	Poor to very poor; high groundwater table
BK	BUCKERFIELD	Moderately fine textured lacustrine deposits	Poor to moderately poor; high groundwater table
BT	BATES	Medium-textured local stream deposits	Imperfect; fluctuating groundwater table
DX	DIXON	15 to 50 cm of moderately fine to fine-textured lacustrine deposits over sand	Poor to very poor: high groundwater table
FD	FADDEN	Medium to moderately fine textured lacustrine deposits	Imperfect
HP	HOPEDALE	15 to 50 cm of medium-textured local stream deposits over sand	Poor: high groundwater table
LK	LICKMAN	Medium-textured local stream deposits	Moderately well
ME	McELVEE	Medium-textured local stream deposits	Poor: high groundwater table
PR	PREST	Medium to moderately fine textured floodplain deposits	Very poor: high groundwater table
SD	SARDIS	Coarse to moderately coarse textured local stream deposits	Moderately well
SM	SUMAS	Coarse-textured lacustrine deposits	Very poor to poor; high groundwater table
VD	VEDDER	Moderately fine to fine-textured lacustrine deposits	Poor: high groundwater table
VY	VYE	Moderately fine to fine-textured lacustrine deposits	Imperfect: fluctuating water table

KEY TO LAND CAPABILITY FOR AGRICULTURE FOR CASE STUDIES


capability rating
limiting subclasses
5^{M}_{T} (4T) [4x]
improved rating after irrigation
improved rating after drainage

CAPABILITY CLASSES

1 - widest range of crops
2 -) reduced range of crops
3 -) caused by a number of
4 -) limiting factors (subclasses)
5 - only permanent pasture or forage
6 - natural grazing
7 - no productivity

LIMITING SUBCLASSES

D - undesirable soil structure
M - moisture deficiency (droughtiness)
P - excess stoniness
R - shallow depth to rock
T - adverse topography
W - excess water
x - combination of soil factors

MAPS NOT

FILMED

CARTES

OMISES

Mosaic - Case Study I

The Vedder Canal crosses the study area and forms the divide of two major soil types. West of the Vedder Canal are sandy loams of the Sumas Soil Series which are derived from glacial lacustrine parent material. These soils are saturated for much of the growing season if not drained. If drained, the low moisture holding capacity of these soils causes them to become droughty. Most of the area is drained and subirrigated. A portion of it receives surface sprinkler irrigation. If both drained and irrigated, the Sumas Soils have an agricultural capability rating of class 1. To the east of the Vedder Canal, the coarse textured lacustrine deposits have been overlain by recent fine textured stream deposits such as the Bates and McElvie Soil Series. These soils are harder to drain than the Sumas soil but have high water retention values and are seldom irrigated. In general, these soils cannot grow as wide a range of crops as the Sumas soil and have an improved agricultural capability rating of class 2 or 3. The height of the groundwater table during the growing season depends, to a large extent, on proximity to the mountain. The southeast corner of the study area is close to Vedder mountain. The high watertables in this area have given rise to organic soils such as the Annis Soil Series. The Annis soils are rated as class 4 for agricultural capability without drainage and class 3 with drainage.

All of the study area is within the Agricultural Land Reserve. The continued agricultural use of the area is supported by both Central Fraser Valley and Fraser Cheam Regional Districts.

Linear Development

There are four separate rights-of-way in the study area. Each is operated by a separate company and follows a separate route through the Sumas Valley. The Canadian National Railway and Trans Canada Highway are also in the Sumas valley but are to the north of the study area.

Westcoast Transmission operates a double or "looped" gas pipeline through the study area. These pipelines can be seen as two parallel lines between the indicator lines. The right-of-way is 60 feet (18.2m) wide. The northern pipe is 30 inches in diameter and was installed in 1956. The second pipeline is 36 inches in diameter and was installed in 1971.

The only station along this line is a control valve just west of the Vedder Canal that occupies about 0.1 ha.

B.C. Hydro and Power Authority operates three adjacent high voltage transmission lines in a single 450 foot (137m) wide right-of-way through the study area. The northernmost line is the Kelly Lake to Ingledow 500 kV line. All of the tower structures along this line are standard steel lattice design with 8.0 m by 8.0 m bases. The second line is the Nicola Lake-Ingledow 500 kV line. The tower structures of this line are identical to those of the previous line and are match-stepped to them. Matchstepping is the practice of aligning towers of adjacent electric transmission lines so that the towers of adjacent lines are as close as possible to each other. In theory this practice leaves as much of the field untouched by towers as possible. The third line is the Atchelitz to Ingledow 360 kV line. The major tower type on this line is a steel lattice H-frame tower. Each tower has two 2m x 2m bases. These towers are also match-stepped with those of the other two lines. Only the 360 kV line is attached to the Atchelitz Substation which occupies about 2.5 ha on the eastern edge of the study area. B.C. Hydro also operates the B.C. Hydro Electric Railway which crosses the southeast corner of the study area. This railway consists of a single set of tracks on a 30m wide gravel pad.

Trans Mountain Pipe Lines Co. Ltd. operates a single 24 inch diameter crude oil pipeline that crosses the southeast corner of the study area.

Agricultural Development

Agriculture has long been a dominant force in the study area. George Winter in The Lower Fraser Valley : Evolution of a Cultural Landscape (Siemens, 1968) states that "except at Langley and on small plots along the Cariboo Road, the earliest systematic attempts at farming were at Chilliwack and in the Sumas Valley". In the early 1860's early settlers, including the Vedders and Millers, established farms on the open prairie. Using the 1858 gold rush as a market and the Fraser River and numerous sloughs for transportation, agriculture flourished in the study area, and

B.C. joined Confederation in 1871, nearly all of the Sumas prairie had been pre-empted. Production included dairy products, poultry, grain, and vegetables.

As the gold rush dwindled and Vancouver and New Westminster grew, attention was focussed on the city markets. Prior to the development of the B.C. Electric Railway to Chilliwack in 1909, milk for Vancouver was derived from Sea and Lulu Islands. Since the introduction of the railway, milk has been the most valuable product of the study area. The railway was instrumental in giving Sumas farmers access to the Vancouver market.

Over-production of milk and chaotic price fluctuations prompted the Milk Industry Act of 1956. Under this Act, each farmer received a quota for the percentage of fluid milk sold to total product times his average lowest four months of production. The price for non quota milk is low in relation to the high production costs in the valley. This system makes milk quota itself a valuable commodity.

Another factor in dairy farming in the study area is the immigration of Dutch farmers after World War II. This influx brought a progressive attitude toward modern farming methods, and new capital and ideas to the dairy industry. In 1966 Margaret Ginn (Siemens, 1968) estimated that 25% of the dairy farmers in Sumas were Dutch. A major change that was encouraged by the Dutch has been to use land intensively to produce a harvested feed such as hay or silage rather than relying on pasturing of animals. Improved drainage systems is probably the major technical advance encouraged by the Dutch.

With the increase in the size of the Vancouver market, the fixed land base and the use of larger labour saving machinery, the minimum size of an economic dairy farm has grown from 20 cows in 1957 to 36 cows in 1968 to around 60 cows today.

The following statistics from the 1971 and 1981 census (Table 3-1) show the increased emphasis on improved farmland, silage and small fruit

TABLE 3-1 AGRICULTURAL STATISTICS FOR CASE STUDY 1

	B.C.		Central Fraser Valley Census District		Fraser-Cheam Census District	
	1971	1981	1971	1981	1971	1981
Population:	2,184,621	2,744,467	58,063	115,012	46,119	56,934
# of Farms						
Total	18,400	20,012	2,617	2,814	1,248	1,109
Sales over $2500.	8,625	13,597	1,374	2,002	692	810
Dairy	1,633	1,345	485	328	420	306
Land Area (ha)						
Total	89,310,362	89,310,362	70,191	70,191	1,080,322	1,080,322
In Farms	2,356,661	2,178,673	36,904	38,274	23,398	24,219
Improved Farmland	710,348	946,363	29,046	32,088	18,397	19,876
Corn silage	5,242	11,729	1,056	2,506	1,192	3,346
Hay	207,574	290,238	9,701	10,805	5,662	6,360
Vegetables	7,250	7,867	1,949	1,635	1,414	1,952
Small Fruits	3,983	5,580	1,226	2,250	321	231
Livestock						
All cattle	573,171	789,840	54,513	65,074	32,830	45,326
Dairy Cows	80,485	89,279	22,274	22,836	17,117	20,289
Beef Cows	184,308	233,911	4,775	5,543	1,740	2,895

Source: Ministry of Agriculture and Food (Sept. 1982)
Census of Agriculture Statistics British Columbia 1971 and 1981, Victoria, B.C.

production, a decrease in the number of farms and the large increase in population that is largely related to urban and industrial endeavours.

3.1.2 Results of Case Study 1 - Sumas Valley

Information on the interaction between agriculture and linear developments was gathered in several ways. Field inspections were made of the rights-of-way within the study areas. Measurements were made of the uncropped areas around transmission tower bases and the general level of weeds was noted. Yield samples were not taken along the pipeline and electrical transmission lines. Such yield sampling is necessary to accurately evaluate the level of impact. Interviews were held with Don Bates, the Provincial Forage Management Specialist for the Ministry of Agriculture and Food in Chilliwack, and four dairy farmers who farm land that is within one or more rights-of-way. Black and white air photography was examined stereoscopically. The photos were taken in 1979 and are at a scale of 1:10,000.

This information was assembled and analysed by type of interaction. Mitigation measures are discussed under each section. For each type of interaction, linear developments are discussed both independently and in their relationships with each other. The overall effect of each type of linear development is summarized in section 3.1.3.

Building Development

Virtually all right-of-way easements forbid buildings and foundations. On highways, railways and electrical transmission lines this prohibition is fairly complete. Vehicle storage and temporary crop storage has been allowed on pipeline rights-of-way although no such use was made of the pipeline in the study area. This restriction greatly discourages residential and commercial development on large electrical transmission lines. Zoning and the Agricultural Land Commission Act do not permit commercial and residential development of the entire study area so no effect of this interaction is evident in the study area. There are areas closer to Vancouver where an electrical transmission right-of-way is used for pasture while the surrounding land was developed into residential subdivision. Farmers faced with a single right-of-way found little trouble finding alternate building sites. A more serious problem arose where a dairy barn and house were caught between the pipeline and a transmission line. One such case is Walter Vink's dairy farm (location 1 on the study area map). Farm buildings span the entire distance between the Westcoast gas pipeline and the B.C. Hydro Electrical Transmission line. This situation could increase the cost and decrease the efficiency of expansion to this successful dairy operation. A similar situation could exist at the far west side of the study area where a farm is between a road and the Westcoast pipeline. The impact of restriction of farm development could have been largely eliminated by the use of a carefully planned common corridor. Such a corridor could have contained both the pipeline and electrical transmission line and could have been planned so as not to isolate farms between it and the roadway or railway. If the rights-of-way had been located along farm and natural boundaries, most of the problem of restricting farm development could have been avoided. Now that the situation of two close-by but not adjacent rights-of-way exists in the study area, development of milking parlors etc. between them will be discouraged for the foreseeable future. Another minor problem of development restriction was brought up by a farmer. The prohibition restricts the way a farm can be subdivided and so reduces his potential profit should he be able to subdivide. This problem is felt to be small within the ALR where such subdivisions are restricted and since it does not directly affect agricultural income, it is more a matter of compensation rather than an agricultural impact.

Land Fractionation

Modern farm machines such as tractors pulling cultivating and harvesting equipment require minimum areas of land to operate efficiently. Railways and highways and stations such as compressor and substations, are mutually exclusive uses of land. If these exclusive land uses are close together but not adjacent, they can cut off a parcel of land so that it is too small to be used efficiently. Two different levels of this problem were found to occur within the study area. Position 2 on the map shows a narrow strip of land between a dike and the B.C. Hydro Electric Railway. Much of the strip is not farmed at all. Position 3 shows the situation where the Atchelitz Substation has slightly increased the number of turns the farm equipment must make to cover a given area of land. The first of these situations represents a significant impact. The area of land on which agriculture is discouraged is about 3.5 ha and exceeds the amount of land occupied by the Atchelitz Substation. Position 2 is a minor impact, the only result of which is an inconvenience to the farmer. This minor inconvenience could have been reduced by locating the substation on a field boundary as is the gas control valve. Careful location of right-of-way and station can reduce the impact of land fractionation to a minor level.

Land Loss

All linear developments result in some land loss although the amount of land loss per kilometre of length varies greatly. The amount of land loss for each type of new project in the area is reviewed starting from the least impact to the greatest. Partial loss of yield is discussed in the next section. Lost land is defined as areas which are not cultivated because of the linear development.

The pipelines, (the two Westcoast gas pipelines and the Trans Mountain crude oil pipeline), cause the least land loss. All of the pipeline rights-of-way are cultivated except for the control valve and scenting station just west of the Vedder Canal. The only other land losses are small areas around posts located at sharp bends in the Westcoast pipeline at location 4 on the study area map. Over 15 kilometres of pipeline in the study area have resulted in the loss of only about 0.1 ha of land.

The three electrical transmission lines have resulted in considerably more land loss. Three major crops are grown on the electrical transmission right-of-way in the study area. These are pasture, hay, and corn grown for silage. The land lost around towers was found to depend more on the crop grown than on the individual farmer. The least land loss was found with improved pasture. Dairy and beef cattle grazed right up to the concrete block on which each leg of each tower sat. The area inside the steel lattice towers of the 500 kV towers was completely grazed. Land loss in the pasture area amounted to about $1m^2$ per 500 kV tower and $8m^2$ for the steel lattice H-frame tower of the 360 kV line. The reason for the lower loss with the 500 kV towers was the fact that cows grazed under the 500 kV towers but not the 360 kV towers. Since all of the towers are matchstepped at a frequency of 3 towers/kilometre, the land loss on improved pasture was $3m^2$/kilometre for the steel lattice tower and $24m^2$/km for steel lattice H-frame towers. Land loss increased dramatically on hayland. Hay could not be mowed mechanically within an average of 0.5m from the tower base. This translates into a land loss of $81m^2$/tower or $243m^2$/km for the 500 kV lines and $60m^2$/km for the 360 kV lines. This amount of land loss was found not to vary greatly if the towers were matchstepped, or located a distance from each other. Some of this land loss could have been recovered by cutting the hay under the 500 kV tower by hand and moving to where it could be picked up by machine but this is not viewed as economic by farmers at this time. While 50% of the farmers interviewed cut the grass under the towers on a regular basis for weed control, none thought it was worthwhile to harvest it. The largest land losses occur on land used for corn silage production. The limiting factor to how close to a tower a field could be cropped was the width of the multi-row planters that were used. Six row planters are 12 feet wide and difficult, if not impossible, to back up because they are pulled by tractor. The result is a 9m by 17m oval around the 8m square bases of the 500 kV towers that is not cropped. The $115m^2$ per tower[1] of land lost varied about 10% depending on the individual farmer and orientation of the field. This translates into $345m^2$ or 0.035ha of land loss per kilometre. Land loss along the 360 kV line depended on the orientation of the H-frame in the field. If the tower was parallel to the direction of cultivation, the area between the towers was not cropped. This resulted in a land loss of $76m^2$ per tower. If the tower was perpendicular to the direction of cultivation, the area between the two tower bases was cultivated and land loss was lessened to $68m^2$ per tower. An average of about $216m^3$ per kilometre of 360 kV transmission line was lost to cultivation.

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[1] All land loss figures include tower bases

The most common mitigation measure for land loss along electrical lines is to locate the tower along farm, field and fence boundaries. Unfortunately this was not done regularly in the study area. The transmission lines cross the fields diagonally. Several cases where towers were located along fence lines were studied. Where a transmission line straddled a fence line, the additional land loss caused by the tower was reduced by the normally uncropped area along the fence. This would be a metre wide strip for a savings of $17m^2$ per tower. Where a tower did not straddle a fence but was close enough to prevent machinery from passing between the tower and the fence, land loss was increased from 115 to $205m^2$ per tower. This is based on the tower being located 3m from a fence, which is the maximum distance to restrict cultivation.

Another mitigation measure that is employed to reduce land loss is tower design. The study area did not afford a good chance to compare different tower types used for a given voltage. The dead-end three-base towers that are used on turns in the 360 kV line increase land loss from 50 to 100% compared to the normal 2-base towers. "Aesthetic" single pole towers (see Appendix 2) would have greatly reduced land loss if they were used in the study area. None of the guyed V towers used by B.C. Hydro are located in the study area. Match-stepping was found to have little effect on direct land loss.

The use of underground cables for electrical transmission as a mitigation measure for land loss in agricultural areas is often raised. Such underground cables would also create additional problems for farmers. The "pot head" stations needed to attach above and underground lines would result in land loss. The underground electrical cables would create all of the impacts associated with pipelines. Maintenance procedures on underground cables are lengthy. Compared to other major mitigation measures such as single base steel poles, underground cables are expensive. The use of special tower and longer routes along boundaries could double the cost of a transmission line. An underground transmission cable would multiply cost by 6 or more times.

Land losses along a railway are much greater than those along an electrical transmission line. The B.C. Hydro Electric Railway with a 30m wide bed and 35m wide strip of land removed from cultivation removes a wide bed and 35m wide strip of land removed from cultivation removes a total of 3500m^2 or 0.35 ha of land from cultivation per kilometre. This is ten times more than a 500 kV electrical transmission line.

The largest source of land loss within the study area is roads. Although the Trans Canada Highway is not in the study area, its removal of land would far exceed that lost to railways.

Loss of Yields on Cropped Land

Three sources of yield loss on cultivated land were found within the study area. The first was loss due to weeds which occurred around electrical transmission towers but not on pipelines. The second was changes in drainage patterns and soil organic matter that was noticed above pipelines. The third was soil compaction which was found in the immediate vicinity of transmission towers. This loss could not be quantified as the crops had been harvested and such yield testing was beyond the scope of the study.

Weed concentration around transmission towers was found to depend greatly on the crops grown and on the weed control methods used. Farmers felt weeds were a real obstacle to corn production. One farmer uses "Round-up" a post emergent herbicide under towers in corn fields to cut down weed spread. Several farmers regularly cut grass and weeds by hand under towers. Normally towers in hay fields received less treatment for weeds than towers in corn fields. Towers in pastures received little or no weed control. Weed control measures were estimated by the farmers interviewed to cost roughly $20. per tower per year. Farmers receive only a single lump sum payment for a transmission line and no annual compensation for weed control. Where corn was grown, the loss of yield due to increased weed populations around a tower was estimated by farmers at 2-3 tons (equivalent to 0.1 ac) at a price of $40/ton this would be about $80. to $120. per tower per year. The yield loss without weed control for hay would be about 0.6 tons or about $54. per tower per year if hay is valued at $90/ton. These figures should be viewed as general levels because factors such as background weed levels, individual farming methods, weather and many other factors would affect them. The loss of yield on improved pasture due to weeds around towers is substantially less than the loss for cultivated fields. The above figures represent losses which would be caused by a single 500 kV line similar to those in the study area.

Match-stepping of towers of three lines had several beneficial effects. The cost of applying weed control spray was reduced by 20 to 30% based on farmers' experience. The area affected by weeds per tower is lowered by grouping towers in the same immediate area. Any measures which lower land loss will also lower weed loss by restricting the nurse area for weeds under towers. In this regard, any successful mitigation measure for land loss will also be a mitigation measure for loss of yield caused by weeds.

The following recommendation can be made with regard to weed control around transmission towers. If no control measures are taken for weed spread around towers, loss can exceed $400. per year per kilometre. For this reason weed control measures are advisable. Little formal research on which weed control measures are effective and efficient has been published. A comprehensive research project is needed to study weed control under transmission lines. General mitigation measures for weed control would be location of towers on farm, field and natural boundaries and reduction in size and frequency of tower bases.

Another source of loss of yield was reported by three out of four farmers who cultivated over the Westcoast Transmission gas pipeline in the study area. They report that while the grass or corn over the pipelines starts growing earlier in the season, the final harvested yield was as low as half that of the rest of the field. The fourth farmer stated that there was no discernable continuing difference in yield. The affected area was reported to be about a 1 to 2m wide area over the pipeline itself and not the 18 m right-of-way. Inspection of air photographs showed a possible reason for this discrepancy. The farmer who reported no continuing yield difference was on the Sumas Soil (location 5). The pipeline would make little difference in the coarse-textured Sumas soils. The farmers who reported the highest continuing yield difference were near location 6. The pipeline clearly makes a difference to drainage on these medium textured Bates and McElvie soils.

All farmers reported temporary loss of yield along pipelines for a few years after construction. The cost of purchasing replacement feed for this period is paid as compensation. A worst case for continuing loss along a single pipeline through a fine-textured, poorly-drained area would be 50% of the value of corn crop over a 2m wide strip, or 0.2 ha/km x 62 tons corn silage per ha x $40./ton of corn, or about $500./km of pipeline. On most soils yield loss would be much less than this. Hay and pasture would have lower values per ha. The use of drain lines would, in most cases, eliminate most of the yield loss if subirrigation was also practiced during the summer.

The problem with continuing yield loss is sufficient to warrant further research. Yield studies to quantify the problem are needed followed by trials of drain lines as a mitigation step if the yield studies warrant this. The use of multiple pipeline rights-of-way and locating pipelines through coarser textured soil are also mitigation measures that should be considered.

The third source of yield loss was noticed immediately around electrical transmission towers. The area within 3m of the tower often had tire ruts and more bare spots than the surrounding field. This problem was much more pronounced on fine textured soils. The area around transmission towers has increased traffic from two sources. The major one is caused when two or three passes have to be made by a tractor around a tower. A minor source of increased traffic is caused if machinery is used for specialized weed control measures around towers. No quantitative measurements were made. Some of the yield loss around towers reported by Kornelis, T. et al (1977). The area subject to this kind of yield loss is about 132 m^2 for a 500 kV steel lattice tower. Assuming a 20% reduction in yield of hay, the loss would be approximately 0.04 tons, or about $3.50 per tower per year. Half of this area is not cultivated for corn due to the problems of getting a 12 foot wide planter near the tower (see land loss). The loss in corn yields would be about the same as hay. The problem with compaction in fields normally used for pasture was found to be considerably less.

Time Loss

No time trials were made to determine the time lost due to avoiding transmission towers. All farmers interviewed stated that a few minutes were lost during each operation due to avoiding towers. Fortin (1980) measured average time losses for guyed towers of between 2 and 3 minutes per operation. The actual amount of time loss experienced by a farmer will depend on such factors as size of machinery used and the number of field operations undertaken each year. Farmers reported that equipment pulled behind a tractor was harder to manoeuvre around towers than self-propelled equipment. If operator time is valued at $50.00 per hour and seven operations are completed a year with a 2.5 minute time loss for each tower, the total annual loss would be $5.83 per tower per year or$17.50 per kilometre of 500 kV line per year. Time trials would be needed to determine actual time losses for a variety of crops.

Since time loss is caused by going around the land that is lost to cultivation, the mitigation measures that reduce land loss around towers will also reduce time loss. Locating towers along field, farm and natural boundaries can greatly reduce time loss. Towers with smaller bases will also reduce both land and time loss. Match-stepping of towers would have little effect on time loss.

No time loss was reported along pipelines.

Increased Costs Immediately Around Towers

All farmers report that field operations including cultivating, planting, spraying, fertilizing and harvesting are repeated twice in the area immediately around a tower. The time loss for avoiding the tower was discussed in the previous section. The extra fertilizer, herbicide and machine costs added to the area immediately around towers contributed little or no yield to the farmer. The area which received double treatment was approximately 132 m^2 for corn. Affected areas for other crops grown in the study area would be slightly lower. Using Financial

Statement for a 60 cow Dairy Herd published by the Economics Branch of the Ministry of Agriculture and Food, the following increased annual costs for the area immediately around towers were estimated:

A. Corn

Seed	$ 56./ha
Fertilizer	222./ha
Herbicide	18./ha
Machine cost	264./ha
Total	$560./ha x 0.0132 ha/tower =
	$ 7.4/tower per year

B. Hay

Seed	(1 seeding each 5th year, i.e.$106./5)	$ 21./ha
Fertilizer		109./ha
Baling twine		6./ha
Machine costs		189./ha
Total	$325./ha. yr. x 0.01 ha/tower =	
		$ 3.25 per tower per year

C. Pasture

Seed	$ 21./ha
Fertilizer	109./ha
Machine Costs	170./ha
	$300./ha/yr. x 0.1 ha/tower =
	$ 3.00 per tower per year

These figures are only very rough approximations. They are intended merely to show the magnitude of impact. Mitigation measures for these impacts are the same as for land loss and time loss. These measures include the use of towers with smaller bases and positioning of towers along farms, fields and natural boundaries. No similar impacts were encountered for pipelines roads or railways.

Increased Access

None of the farmers interviewed reported any problems with increased access. Maintenance crews for both B.C. Hydro and Westcoast Transmission were said to be considerate and always request permission before entering a property. The only incident reported was that of a replaced metal spacer used on a B.C. Hydro high voltage transmission line that was inadvertently left in a hay field by a maintenance crew and damaged a piece of farm machinery. Increased access was viewed as a slight inconvenience in the study area.

Irrigation and Drainage

The Lower Fraser undergoes a period of heavy rainfall from November to April. During this period, excess water must be removed from the field. This is especially true in hay fields where excess water will lead to winter-kill of palatable grasses and encroachment of sedge type grasses which have little forage value. In order for many low lying areas to be farmed, extensive ditch and pumping facilities must be installed on a regional level. This is true of the entire study area. On fine textured soils, such as those east of the Vedder Canal, subsurface drain lines are necessary to carry the water from the field to the regional ditches. The hydraulic conductivity of these soils is insufficient to remove all of the excess water. The problem is compounded near the mountains where the discharge from large groundwater systems must also be removed. This is the case in the Annis and neighbouring soils in the southeast corner of the study area. During July and August the Lower Fraser valley experiences a severe drought. The 500 mm water deficit is often made up in part by natural and artificial subirrigation, Goldstein (1980). In coarse-textured soils such as this Sumas soil, surface irrigation is also required.

The linear developments in the study area were found to affect the water relations of the land they crossed.

The electrical transmission lines did not appear to affect drainage on either a farm or regional level but did affect irrigation. One farmer located on the Sumas soil who wished to use his wheel-move irrigation equipment on a field containing three transmission towers had not done so because of the transmission towers. He now uses hand-moved pipes to irrigate this field.

Automated irrigation equipment falls into two categories. The first employs long moving pipes with sprinklers attached. In the Lower Fraser Valley, the most common of these are wheel-move systems with long pipes that move back and forth perpendicular to the pipe on large wheels. To be compatible with transmission lines, the pipes have to be shorter or more separate pipes have to be used. Both of these techniques would add both capital and labour costs to a system. Another pipe type irrigation system is the centre pivot. In this system a pipe swings around a central water source. A real advantage of the centre pivot system is that an operator is not needed to connect the pipe to a separate hydrant each time the pipe is moved. The specialization of hay production, increase in farm size and development of centre pivots with legs that work on square fields might bring centre pivots into common use in the Fraser Valley. Centre pivots can be located near transmission lines if towers are located in unused corners. Another solution is the "windshield wiper" pivot that changes direction each time it encounters a tower. Both of these methods increase the capital cost of an irrigation system and lessen the uniformity of water distribution, but they do not increase labour costs.

The second type of automated irrigation system relies on high speed water jets to distribute the water. The two types of this system operating in the vicinity of the study area are small manually moved or permanently mounted water cannons and the reel type irrigators which once set are constantly reeled back to a hydrant. The small water cannon system is generally compatible with transmission lines. The large reel systems produce a spray which, under pressures up to 100 psi, are capable of crossing a transmission line and conducting current to ground. This is called "flashover". For this reason, such systems are not used in fields crossed by transmission lines. Many farmers consider this reel type irrigator the most suitable type for the Lower Fraser Valley.

Several mitigation measures are of potential benefit where the electrical transmission lines cross fields which require irrigation. Positioning of towers along farm, field, and natural boundaries is not always possible but would substantially reduce impacts on irrigation. Match-stepping reduced the number of fields that had towers in the study area. Matchstepping could make designing an irrigation system around towers easier. The most appropriate mitigation measure seemed to be the use of smaller lower pressure reel type irrigators. Although not suitable for all fields and crops, such systems combine fairly low (but not as low as centre pivot and high pressure reel systems) labour costs with compatibility with electrical transmission lines. The general guidelines for irrigation equipment in "Play it Safe" brochure by B.C. Hydro do not provide sufficiently detailed information to design modern irrigation systems for use under transmission lines. It is difficult to place a value on the impact of electrical transmission lines. One farmer in the study area reported he spent 3 hours per week for a 3 month period moving hand lines which would have been unnecessary with a wheel move irrigator in use in an adjacent field. At $30. per hour a season cost would be over $1000 for the 10 hectare field. This scale of costs could mean that the time lost through interference with irrigation equipment is the highest impact on farming areas that require irrigation. On a kilometer basis, costs of over $3000 per kilometre per year are possible. The above estimates do not take into consideration many variables, such as the higher capital costs of the automated irrigation system that would be needed to avoid the time used in hand-move systems on fields without towers versus systems specially designed for transmission line rights-of-way. Interference with irrigation by transmission towers can adversely affect areas much larger than the right-of-way. If transmission lines are located on soils such as most of those to the east of the Vedder Canal where irrigation is not practiced or practical, then no impact on irrigation will occur.

Pipelines do not affect surface irrigation but can affect drainage and subirrigation. This affect is based on the fact that the hydraulic conductivity and soil water retention characteristics of the pipeline trenches are different from those in the surrounding soil. The effect may be beneficial, detrimental, or both at different times of the year. In coarse-textured soils, the difference in the characteristics of the trench and surrounding soil would be much lower than in fine-textured soils. Farmers on fine-textured soils reported that grass and corn crops started earlier but provide a smaller harvest (see yield loss section) over trench lines. The farmer interviewed on the Sumas soil reported earlier growth and no difference in yield. Many of the fields in the study area have some type of drain lines. The drain lines at location 7 were recently installed when the air photo was taken. They show how the alignment of drainlines had to be modified around the pipeline. Drainlines would reduce the difference in hydraulic conductivity characteristics of the trenches as compared with the rest of the field. Pipeline companies may pay the increase in cost of drainlines due to the presence of pipelines. In all cases, the pipeline company should be informed before any trenching is done on the right-of-way.

There have been reports of highways and railways changing drainage and subirrigation. It was beyond the scope of this study to determine the importance of soil effects. Such effects should be considered if major roads or railways are put through areas with naturally or artificially high watertables or areas of importance to agriculture.

Electrostatic and Electromagnetic Effects

Energized electrical transmission lines give rise to electric and electro-magnetic fields. These effects, real, perceived, and rumoured, are of concern to all of the farmers interviewed. Two distinct phenomena were consistently reported by farmers along with several concerns that were viewed as inconveniences.

The most important phenomenon was "tingle voltage". If a milking parlor has stray voltages, there is a possibility that a cow being milked and a milking machine will be at different voltages. These voltages can be in the range of 1 to 5 volts. The electrical shock thus generated can cause a cow to go dry temporarily. A milking machine operating on a dry teat often causes irritation and inflammation which may lead to a mastitis infection. These infections, which have many other causes, increase bacteria counts in milk and can necessitate the culling of a cow. The B.C. Department of Agricultural Engineers Note 324.5-1 describes a system of grounding a milking parlor to prevent this problem. This system costs approximately $3000. in an existing parlor but less than half that in a new parlor. The same publication blames the problem on "electrical pollution". Chris Dyble, a Professional Agrologist with B.C. Hydro, stated that he provides free advice to dairy farmers on the causes and cures of tingle voltage on specific farms. Both Mr. Dyble and the preponderance of material on the subject available from the B.C. Ministry of Agriculture state the usual cause is improper wiring or grounding of farm machinery. Another possible cause is imbalances on 3-phase lines. Two of four farmers interviewed reported serious tingle voltage problems. One had lost a cow. Both had spent thousands of dollars to reground milking parlors. A third farmer reported a minor problem that was easily solved. At most, transmission lines can be considered to be a contributing factor to problems such as tingle voltage. Electrical transmission lines are only one source of "electrical pollution". One of the causes of tingle voltage on one of the farms appears to be induction of electricity from the B.C. Hydro transmission lines into an electrical fence which was in turn connected to a circuit inside the milking barn. Mr. Dyble supplied the farmer with a filter meant to diminish or eliminate this problem. The battle against tingle voltage on this farm had been long and expensive. Since transmission lines can act as a contributory effect to stray voltage, dairy farming areas should be avoided during the route selection process. Where transmission lines are developed near milking parlors, special efforts should be taken to protect the farmer from stray voltages. Additional research is needed into the causes and cures for tingle voltage. One inexpensive way to clear up disagreements as to the effect of transmission lines on tingle voltage is to map persistent tingle voltage problem sites in the Lower Fraser Valley to see if any discernible pattern is found. Pipelines may also slightly affect ground potential due to cathodic protection and their role as a conductor.

The other major complaint is that of electrical shocks received due to the electrical transmission lines. The major type is transient electric shock. This occurs when a person or animal touches an object that is at different electrical potential. These shocks last only a small fraction of a second during which time the current is quite high. All farmers interviewed report this type of shock when operating farm machinery directly underneath the line. As can be seen from the study area map, some farms have over twenty percent of their fields within the B.C. Hydro right-of-way. These farmers spend considerable time under the lines. One farmer reported a greater incidence of shocks when pulling a plough through the soil. These shocks are reported to be unpleasant. Full compliance with B.C. Hydro and CSA clearance standards would ensure that there was no potential for dangerous shock no matter what combination of weather conditions and electrical load occur. Steady state shocks were also reported but occurred rarely. The only instances were related to electrical fences that passed under the power lines. These electrical fences are frequently moved to new locations. A clear set of grounding and moving instructions is needed for electrical fences used under electrical transmission lines. Ungrounded metal fences (both non-electric and electric), buildings, roofs, gutters and storage tanks should therefore be grounded before transmission lines are energized in their vicinity. A worst-case current of 5 mA, approximately one half the "let go" threshold for adult men, is taken as the maximum safe level by the Canadian Safety Association. The "let-go" threshold is the point where a hand could not be voluntarily removed from a conductor due to the amount of current flowing through the body. It is B.C. Hydro's policy to investigate all complaints and ground all metal objects that show induced voltages from transmission lines.

The farmers interviewed were aware of "flashover", a large electrical discharge that could occur if a grounded conducting object is brought close to an energized transmission line. Farmers were careful in handling long pipes under the lines but did not view the lines as a major risk. Corona effects such as radio and television interference and audible noise were reported by all farmers. These were viewed as inconveniences and nuisances and did not appear to have significant effects on agriculture.

Several steps are possible in mitigating electrical effects. B.C. Hydro is in the process of preparing a report on standards for audible noise, radio interference and field strength. This document should be independently reviewed to insure that the proper standards are applied to intensively used agricultural land where farmers live and work in close proximity to electrical transmission lines. Minor design changes to farm machinery and operating procedures under transmission lines could reduce shocks. More public documentation on grounding procedures for electrical fences and similar situations is needed. More research is required with regard to tingle voltage. Avoiding dairy areas during the route selection process for electrical transmission lines seems reasonable.
With an average farm size of 100 acres, these areas are densely populated by agricultural standards.

3.1.3 Conclusions

Case Study 1 - Sumas Valley

Electrical transmission lines were found to have few benefits and several negative impacts on agriculture in the study area. These impacts included restrictions on building development and impacts directly associated with transmission towers, including land loss, time loss, increased field costs, yield losses, and interference with irrigation equipment. These impacts were found to be affected by tower type, tower size and location in the field. The crop grown was a major factor in determining actual costs to the farmer. On land used for silage corn, land loss was approximately 115 m^2 per tower, land loss to pasture was only about 1 m^2 while land loss in hay fields was 81 m^2 per tower. Time loss and related impacts also follow this pattern. The use of mitigation measures such as the use of towers with smaller bases and location of towers on field boundaries would have reduced impacts in the study area.

Match-stepping, which was practiced, was of some benefit. Location of multiple electrical transmission lines in the same right-of-way probably reduced these impacts slightly overall but intensified impacts on the combined right-of-way. Interference with automated irrigation systems was found to depend on soil and groundwater conditions. On coarse-textured soils where irrigation is practiced, interference with automated systems could represent the highest impact as it affects a larger area than the right-of-way. On soils where no irrigation will be practiced, there would be no impact of this nature. Match-stepping and use of multi-line rights-of-way reduced interference with irrigation systems. Location of towers on field, farm, and natural boundaries, and use of towers compatible with automated irrigation systems would further reduce these impacts. Electrical effects of transmission lines were found to include nuisances such as shocks, audible noise, and radio interference.

The most important electrical effect was the contributory effect that induced voltages on fences and buildings can have on tingle voltages in milking parlors. Increased access and line maintenance were not important impacts in the study area.

Pipelines in the study area were found to have few beneficial impacts on the study area. The negative impacts of pipelines on the study area were confined to restrictions on building development, temporary yield loss, the first few years after construction, and continuing loss of yield above trenches on fine-textured soils. Continuing yield loss is the most serious of these impacts. A worst case of $500. per kilometre per year was estimated. Route selection, the use of drainlines for drainage and subirrigation and importation of topsoil are possible mitigation measures for this problem. Additional costs for installation of drainlines occurred along the pipeline. In some cases this increased cost would be born by the pipeline company. Land loss, time loss, increased field cropping costs, increased access, and interference with irrigation were found not to be significant impacts on the pipeline right-of-way in the study area.

Roads and railways were sources of major land losses. They, along with dikes, lead to a significant amount of land fractionation. As roads and railways are exclusive uses, land use impacts such as yield and time loss do not apply.

During the interviews with farmers, several deficiencies with the present system of compensation were noted.

1. Compensation was given to the owner, not to the farmer who often rents the land.

2. Compensation represented the value of the impact on the land when the project was constructed. Since the 1950's and 60's when the electrical lines and first pipelines were constructed, land use has gone from poorly drained pastures to intensive production of silage corn. The impacts on silage corn production are far greater than for pasture.

3. Compensation is normally given on a one time basis. The present operator has to absorb the costs even though the sale price of the land does not take impacts into consideration.

4. Farmers are unfamiliar with impacts of linear development during negotiations for easement.

5. Impacts due to the combined effects of two or more projects are usually not considered.

6. Farmers are often not consulted during the route selection process.

7. Farmers are not aware of their options when approached for right-of-way easements.

8. Compensation paid to an individual does little to replace the losses to the agricultural industry or the consumer. Compensation in kind, such as developing alternate agricultural land, could compensate both owner and the general public.

In conclusion, use of alternate routes and more adherence to mitigation would have been advisable for the electrical transmission lines, pipelines and railway in the study area. Many of the existing impacts could have been reduced or elimінted with such mitigation measures. The realized level of impact of linear developments has increased with the passage of time since these projects were built due to more intensive farming methods and larger farm machinery.

3.2 Case Study #2 - The Fraser Plateau

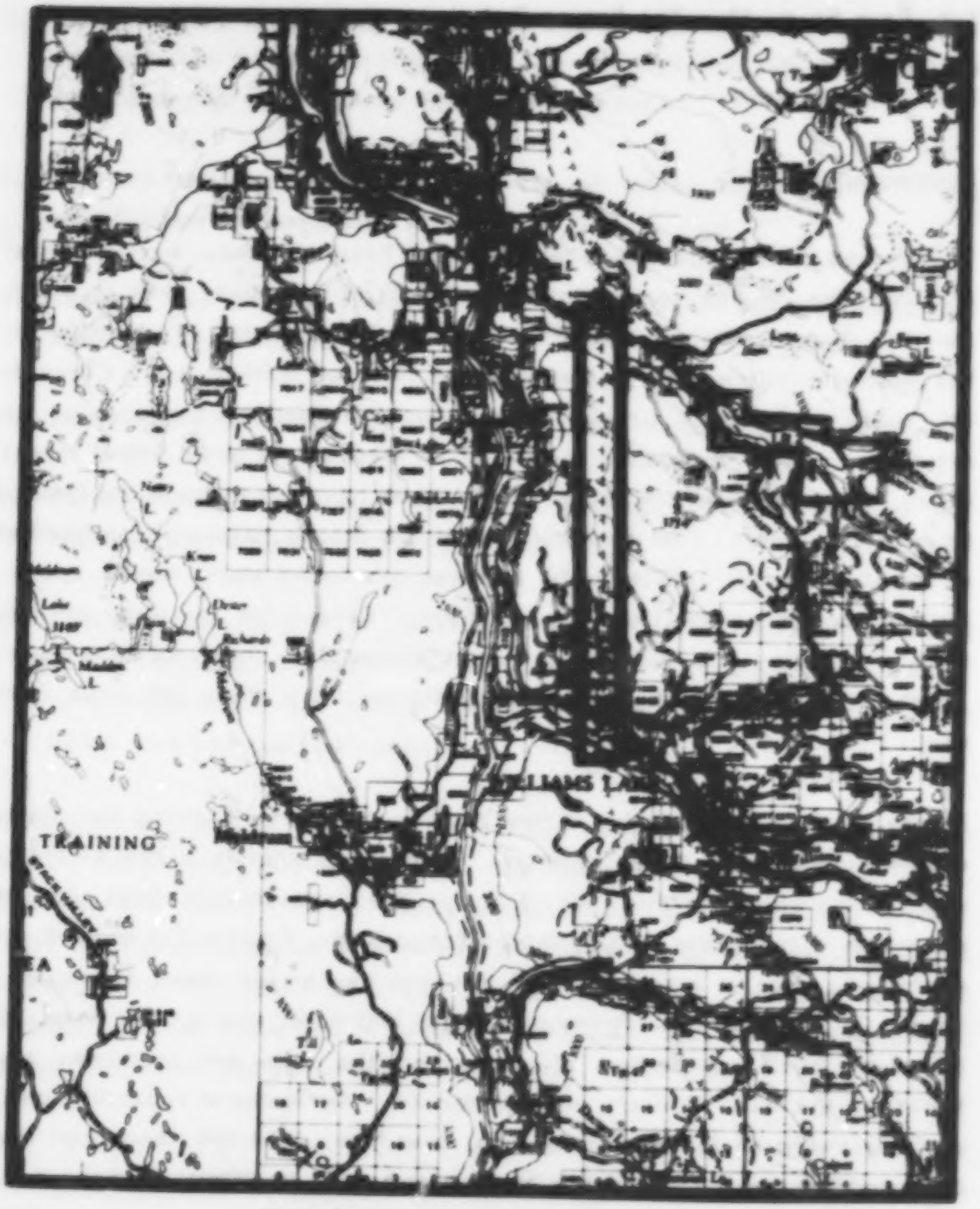
3.2.1 Background

Physiography

The second case study was located on the Fraser Plateau, just north of Williams Lake, in the central interior of B.C. The study area is within the Bull Mountain Range unit. This unit lies between the Fraser River to the west and Highway 97 to the east and between Williams Lake Creek in the south and Hawks Creek in the north. Most of the area is an extensive, gently undulating plateau at an elevation of about 900m. Hawks Creek, Whiskey Creek and Williams Lake Creek have cut through the Plateau from east to west. The level bedrock of the area is covered by a blanket of drumlinized till. Glaciofluvial terraces are found along Hawks Creek, Williams Lake Creek and the Fraser River. Except for the major rivers, terrain of this type imposes few restrictions for linear developments. Three B.C. Hydro high voltage transmission lines cross the area from north to south.

Figure 3-3 is a location map of the Williams Lake area showing the study area and location of linear projects. The study area is a two kilometre wide strip which follows the B.C. Hydro transmission lines for 10 kilometres through the Bull Mountain Range Unit. Figures 3-4 and 3-5 are study area maps at a scale of 1:10,000 that use an air photo mosaic as a base. Grazing unit boundaries plus fields and water courses are shown on the map. Soil associations are based on the soils and landforms map 93B/1 by the B.C. Ministry of Environment. Agricultural capability units are also shown on the study area map, based on a 1:50,000 manuscript map produced by the B.C. Ministry of Environment. Modifications have been made in both soil associations and agricultural capability based on field observations.

The soils in the study area can be divided into two basic types; those derived from glaciofluvial terraces and those derived from extensive morainal deposits. Two soil associations are located on glaciofluvial terraces. The Hawks soils are sloping areas of gravelly sand without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Case Study Site #2 Location Map

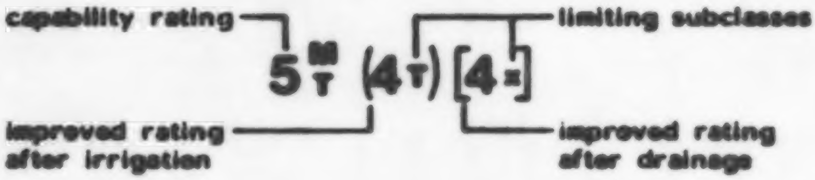
Scale 1:125,000

SOIL ASSOCIATIONS LEGEND

Symbol	Soil Association	Soil Type	Surficial Material	Texture	Drainage
C	Cinema	Orthic Gray Luvisol	morainal blanket	gravelly loamy sand	well
HA	Hargreaves	Orthic Eutric Brunisol	glaciofluvial with aeolian capping	loam	well
HS	Hawks	Orthic Eutric Brunisol	glaciofluvial	gravelly sand	rapid
TE	Tyee	Orthic Gray Luvisol	morainal	gravelly loam	imperfect
WC	Whiskey Creek	Orthic Eutric Brunisol	colluvial	gravelly loamy sand	well
WL	Williams Lake	Orthic Gray Luvisol	morainal	gravelly loam	moderate

From: Map 93B/1 Soils and Landforms Map
(1972) Resource Analysis Map, B.C. Ministry of Environment

KEY TO LAND CAPABILITY FOR AGRICULTURE FOR CASE STUDIES


capability rating
limiting subclasses
5 M/T (4 T) [4 x]
improved rating after irrigation
improved rating after drainage

CAPABILITY CLASSES

1 - widest range of crops
2 -) reduced range of crops
3 -) caused by a number of
4 -) limiting factors (subclasses)
5 - only permanent pasture or forage
6 - natural grazing
7 - no productivity

LIMITING SUBCLASSES

D - undesirable soil structure
M - moisture deficiency (droughtiness)
P - excess stoniness
R - shallow depth to rock
T - adverse topography
W - excess water
x - combination of soil factors

MAPS NOT

FILMED

CARTES

OMISES

Mosaics - Case

Study # 2

much agricultural capability.(classes 5, 6, and 7) The Hargreaves soils are developed on flat terraces with aeolian capping of fine sand and silt. Without irrigation these soils support natural grasslands that support important spring and fall rangeland. With irrigation, these soils are a major source of forage for winter feeding of beef cattle. With irrigation the Hargreaves soils are rated as class 2 agricultural capability but only class 5 without irrigation. The Tyee soil association is the most extensive of the morainal soils. Like the Williams Lake soils, the Tyee soils are drumlinized with dry, water-shedding ridges and wetter troughs. This uneven drainage characteristic is compounded by a clay enriched B^t horizon at 30 cm depth in the soil and compact till at 80 cm depth. Although with irrigation some areas could produce grains such as barley and oats, yield levels would be low and cultivation would be difficult. For this reason the morainal areas will tend to be used for hay land if irrigated and for pasture or rangeland without irrigation. The poorer drainage of the morainal plateau soils and the need to pump water up to them make it likely that these soils will not be irrigated for a long time if at all. No cases were found in the area around Williams Lake where the Tyee or similar soils were used for anything other than forage, pasture, or range purposes. For this reason the unimproved class 5 agricultural capability rating likely represents the developable capability for the next several decades. If development pressures increase rapidly, this situation could change.

Linear Development

The only linear development in the study area is a B.C. Hydro multiple high voltage transmission line right-of-way. At present this right-of-way includes the following:

B.C. Hydro #	Terminal substations	Voltage	Tower Type
5L11	Williston to Kelly Lake	500 kV	guyed-V
5L12	Williston to Kelly Lake	500 kV	guyed-V
2L94	Kelly Lake to Soda Creek	230 kV	wooden H-frame

An additional 500 kV transmission line is proposed for the right-of-way. The proposed line would have guyed-V towers and be located immediately east of the existing lines. At present the cleared right-of-way width is approximately 130m. The additional line would require clearing an additional 54 m for a total of 184 m. Easements for most of this additional right-of-way have already been obtained.

Agricultural Development

The Fraser Plateau is often referred to as the Chilcotin-Cariboo. Its long history of ranching is an important part of B.C. history. The Chilcotin Indians were grazing horses in the region in the early 1700's. The first ranches in the area were set up in the 1860's. The most rapid period of settlement was in the 1870's with pre-emption under the Land Ordinance of 1870. Overgrazing had significantly reduced the capacity of much of the rangelands by the 1930's. Tighter government control in the 1950's and 1960's resulted in the return of much of the rangeland to a useful state.

The pattern of ranching in the region greatly affects the impacts that transmission line development could. There are approximately 130,000 head of cattle in the region on about 1,165 farms and ranches. Before 1950 most of the cattle were fattened for markets around Vancouver. More recently, operations have been geared to supply calves to Alberta feed lots. Table 3-2 gives agricultural statistics for the Cariboo District.

The cycle of ranching in the Chilcotin begins with the first flush of growth in spring when cattle are turned out into the range. Spring range consists of low elevation grasslands, clearcuts, and organic meadows. Spring range is a major limiting factor to beef production. As more abundant natural vegetation becomes available, the cattle move to higher elevations. These areas are comprised primarily of meadows and clear cuts which are used under Crown grazing permits. The grazing permits regulate animal numbers and season of use by range unit. These units have been determined by a combination of natural barriers, fencing, and

TABLE 3-2 AGRICULTURAL STATISTICS FOR CASE STUDY 2

	B.C.		Cariboo Census District	
	1971	1981	1971	1981
Population:	2,184,621	2,744,467	39,357	59,252
# of Farms				
Total	18,400	20,012	762	996
Sales over $2500.	8,625	13,597	386	717
Beef	2,501	4,558	313	517
Land Area (ha)				
Total	89,310,362	89,310,362	6,916,973	6,916,973
In Farms	2,356,661	2,179,673	322,139	300,927
Improved Farmland	710,348	946,046	54,577	90,638
Oats, barley	115,440	121,342	919	1,032
Corn silage	5,244	11,729	291	313
Hay	207,574	290,238	23,189	36,810
Irrigated Land	89,426	100,477	14,737	15,770
Sprinkler Systems	32,422	82,707	1,626	8,490
Livestock				
All cattle	573,171	789,841	88,176	131,033
Beef Cows	184,304	233,911	38,184	48,960

Source: Ministry of Agriculture and Food (Sept. 1982) Census of Agriculture Statistics British Columbia 1971 and 1981, Victoria, B.C.

historic use. Unlike most of the rest of the province, Chilcotin range units are often used by several ranches. In September and October, the cattle drift back to the home ranch areas for over-wintering. Recently, with the introduction of 3-phase power to many ranches, large irrigation systems have been developed to increase production of hay and alfalfa for winter forage. These irrigation systems have been developed on glaciofluvial terraces with aeolian cappings, which are found along most of the rivers in the region.

Coordinated Resource Management Planning (CRMP) is expanding through the Chilcotin-Cariboo. Many range units have projects under CRMP's that seek to improve grazing capabilities while also increasing opportunities in forestry, recreation, and wildlife industries. Recently, funds for CRMP projects have come from the Agricultural and Rural Development Subsidiary Agreement (A.R.D.S.A.). Projects such as range seeding and improvement and cross fencing for cattle stocking control could be affected by transmission line development.

3.2.2 Results of Case Study 2 - Fraser Plateau

Information on the interaction of agriculture and the electrical transmission lines in the study area was gathered in the following ways. Field inspections were made in December of 1982 of the right-of-way in the study area. These inspections were difficult because of a light covering of snow in the area. Interviews were held with Ross Fredell, the range agrologist for the Ministry of Forests, Mr. Peter Fofonoff, District Agriculturist, Ministry of Agriculture and Food, and several of the ranchers active in the study area. Black and white aerial photography was examined stereoscopically. These photos were taken in 1973 and are at a scale of 1:16,000. Inventory information, including soil type and agricultural capability, was taken from B.C. Government maps and modified on the basis of field inspection. This information was assembled and analysed by the type of interaction. Mitigation measures are discussed for each interaction type. The overall effect of the electrical transmission lines in the study area is discussed in section 3. 2. 3.

Cattle Grazing

The most dramatic effect of the B.C. Hydro right-of-way is on cattle grazing. The majority of the right-of-way is located on Tyee soil association. For the foreseeable future these soils will be used for grazing and improved pasture. The Tyee soils on the right-of-way are found to support a healthy stand of Crested wheat grass. The present yield of this area was estimated at approximately 1.2 animal unit months (AUM) per ha per year. (The Animal Unit is a standard livestock unit and is defined as one mature 1000 lb cow with or without unweaned calf at side or equivalent.) The surrounding area of Tyee soils consists of conifer forest with thinned and cleared areas. The pinegrass vegetation of this area is estimated to yield about 0.4 AUM per hectare per year. The level of increased productivity is due to the clearing and seeding of the right-of-way which was done at B.C. Hydro expense.

The current cleared right-of-way is about 130 m wide. This gives the local rancher an additional 10.4 AUM per kilometre of right-of-way. This would increase to 14.7 AUM per kilometre if the third 500 kV line is installed. Not all of the right-of-way can or should be used for grazing. Steeply sloping land adjacent to Hawks and Williams Lake Creek is not useful for grazing. Portions of the prime agricultural land on the glaciofluvial terraces (Hargreaves soil association) are used for hay production. About 77% of the right-of-way is used for range. The benefits to agriculture can be assessed by looking at the dollar value of the increased grazing, but this would not take into consideration the cost included with utilizing the increased grazing potential. To realize the full benefit of the increased grazing capacity, ranchers have to increase their level of range management accordingly.

The Springfield Ranch which utilizes most of the range in the study area uses a repeated seasonal grazing pattern. Several techniques are used to distribute the animals on the range to ensure that the total available forage is used.

Fencing is an important method of cattle control. The north boundary of the Bull Mountain range is Hawks Creek which functions as an effective natural barrier to cattle movement within or without the right-of-way. Williams Lake Creek is the southern boundary of the Bull Mountain range unit. A cross fence is located north of Williams Lake Creek and is effective in controlling cattle movements. One problem that was reported with cattle management along the right-of-way was abuse of gates on right-of-way maintenance roads. A rancher may lose cattle or spend considerable time retrieving them if a gate is left open. The closing of a gate that a rancher has purposely left open also causes problems. A few incidents of this nature were reported.

Salting and water development are also very important methods used to control cattle distribution. Salting procedures are modified both to prevent over-concentration of cattle on the right-of-way and over-grazing. Such over-concentration could lead to poor utilization of the pinegrass and over-grazing of the crested wheatgrass with resultant poor regrowth and weed infestation where overgrazing has occurred.

Riding and herding are practiced in the study area although fencing, salting and water development are more important. Development of cattle trails, fertilization, and supplemental feeding are other cattle management methods used on the Fraser plateau. Although these cattle distribution methods had to be altered due to the effect of the right-of-way, the ranchers interviewed did not believe these costs increased on a per AUM basis because of the right-of-way.

Weed control followed a similar pattern. The right-of-way had annual weeds such as bull thistle and Canada thistle. These weeds are selectively sprayed both by the rancher and the Forest Service when conditions warrant and equipment is available. Since clipping is not used as a method of weed control over most of the rights-of-way, increased weed population was not found around tower and guy wire bases. The conifer/pinegrass areas surrounding the right-of-way are normally not sprayed.

The costs of range utilization apply equally to the right-of-way and to the rest of the range. There are several ways of evaluating the increased grazing on the cleared right-of-way. If a rancher were to clear and seed himself, the cost in 1983 would be approximately $1000. per hectare[1]. A rancher could also lease privately owned improved pasture for about $10. to $12. per AUM. A single 500 kV transmission line has a cleared right-of-way of 64m or 6.4 hectares per kilometre. This type of line would give the rancher an additional 5 AUM per kilometre, or about $50. per year per kilometre pasture. The present cleared right-of-way yields approximately $100. per year per kilometre based on the above assumptions. The key to realizing this level of gross benefits is the skill of the rancher. There may be a need to train ranchers in right-of-way utilization, and a year or two may be needed to change cattle management plans sufficiently to realize the full benefit of the right-of-way.

Land Loss

The largest amount of land loss in the study area was due to a 4m wide maintenance road which follows most of the B.C. Hydro right-of-way. This road is in fair to good condition and is used by ranchers, B.C. Hydro, loggers, and the general population. The negative impact of this road is the 0.4 ha of range land that is removed from production per km and the disturbed areas to either side of the road which may propagate weeds.

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[1] Source:Consensus Cost Land Clearing and Development in the Prince George District, Economics Branch, B.C. Ministry of Agriculture and Food (1980) Victoria.

The positive impact of this road is the improved access it gives all its users. As can be seen from the study area map, other logging and access roads are found throughout the study area. In general, there is a lack of planning of minor roads in the study area. The right-of-way road may not greatly increase the negative effect of an inefficient road system. It might even improve this system.

The small areas lost at the tower bases and guywire bases was much smaller than the land loss to trees in the surrounding area. Each guyed-V tower only removed about 8 m^2 from grazing. The land loss due to the Soda Creek Substation is about 1 ha. The substation is located on an outcropping of Williams Creek Soil on a glaciofluvial terrace. The topography and soil of this area limited its agricultural capability to class 5 and the land loss did not affect an area which could be used as an irrigated hayfield.

A more significant land loss occurred where the electrical lines crossed hayfields (location 1 and 2). The snow cover made accurate measurement of this land loss impossible. Judging from air photographs, land loss at location 2, 3km north of Williams Lake Creek, was about 100m^2 per 500kV tower and about 34m^2 for each 230kV of tower. Land loss at location 1 (just north of Williams Lake Creek) was caused not by the major transmission line but by a low voltage distribution line. No actual measurements were made of land loss. The rancher reported that interference with irrigation equipment was more important than the land loss in this area. Matchstepping did not appear to be a benefit for land loss. Matchstepping could be a disbenefit because guy wires of adjacent towers were close enough to form an obstacle to field operations.

The greatest land losses were due to highways being routed along glaciofluvial terraces along Hawks Creek. Although this caused the loss of approximately 3 ha of prime agricultural land, it also provided important access to these terraces.

Land Fractionation

Land fractionation was not found to be a major problem. The only incidence of it in the study area occurred where the Cariboo Highway crosses a hayfield west of the Soda Creek Substation. For this field to be avoided, the highway would have had to take sharper curves. The prime agricultural land on both sides of the highway is cultivated. Thus fractionation increased the cost of production but did not cause additional loss of land to agricultural production.

Weed Control

Three distinct ares of interaction of transmission lines and weed populations were found. The most serious is the sharp increase in weed populations immediately following construction. Ranchers noticed increased weed population along the right-of-way and in the area adjacent to it for about 2 years after construction. Early reseeding and a good take helped to reduce this problem after construction of the two 500 kV lines. In addition to the timely re-seeding, a selective spraying program should be undertaken about 2 years after construction. In most areas the range seeder from the B.C. Ministry of Agriculture and Food would provide the best reseeding from a weed control point of view.

Construction practices themselves can be modified to reduce invasion of weeds. Soil disturbance should be minimized during construction. Temporary construction roads should be reclaimed immediately after construction is over.

The second weed problem is on haylands where mowing is an important method of weed control. This situation did not occur within the study area on either the 500 kV lines or the 230 kV line. It did occur along a distribution power line extending west from the Soda Creek Substation.

This line runs through an irrigated hay field at location 1. Small weed populations occur around the wooden poles in areas where the mower cannot reach. The problem of weeds around tower bases could also occur at location 2 where the major transmission lines cross a meadow used for hay and pasture. The major problem with weed population around tower and guy wire bases is that they produce seed and act as nurse areas which increase weed populations in the surrounding area. This problem occurs only where mowing is practiced. Ranchers don't take the time to spray herbicide on the patches of weeds at tower bases, even though such procedures may be cost effective. No value can be placed on yield loss due to weed concentrations around towers without analysing yield samples. The author estimates that special spraying would cost in the neighbourhood of $20. per tower per year. In the mid-term (18 to 20 years) only the better soils such as the Hargreaves soil association and organic meadow will probably be developed into hayland. This represents about 10% of the study area. In the long term, flatter areas of the Tyee soil association may be used for hay. This would greatly increase the area affected by weed problems of this kind.

The third problem is endemic weed population along the right-of-way used for rangeland. Other cleared areas, such as logged-off areas, have similar weed densities as the right-of-way. Both the B.C. Ministry of Forests and the ranchers do some selective spraying of all of these areas. This spraying is viewed as one of the management procedures necessary to take advantage of the increased grazing capacity of the right-of-way.

Irrigation and Drainage

Irrigation is necessary to bring areas with large climatic moisture deficits into full, or in some cases, up to economic levels of production.

Three major factors determine the need for irrigation. These are the climatic moisture deficit, the capacity of a soil to retain water, and the availability of groundwater near the surface. The cultivatable portions of the study area (class 1 through 5) can be divided into three categories by the need for irrigation. The first category is the plateau which has predominantly luvisolic soils. These soils have a clay enriched B+ horizon and can retain significant amounts of water. The plateau is also slightly colder than lower elevations, giving it a slightly lower climatic moisture deficit. Irrigation of this area is not widely practiced at the present time even though it would increase yields. The second type is the glacial fluvial terraces. These terraces are made up of very coarse rocks with thin cappings of fine sand and coarse silt. These areas have little water retention and without irrigation are often sparse grasslands. With irrigation these areas improve from class 5 to class 2 agricultural capability. Most of the hay production in the Williams Lake area comes from irrigated hayfields on these terraces. The third type of cultivatable land in the study area is organic meadows such as those occurring at location 2. These meadows have developed where groundwater gathers in depressions. Organic meadows are an important source of hayland and pasture in the Chilcotin-Cariboo.

Interference with irrigation by electrical transmission towers is mainly a problem for automated sprinkler systems and high pressure reel irrigators. These types of systems are rapidly replacing less water efficient systems such as flood irrigation and more labour intensive systems such as hand move sprinklers. As can be seen from Table 3-2, the amount of irrigated land in the Cariboo census district increased by 7% between 1971 and 1981. During this same period the area of land under sprinkler systems increased by 422%[1]. While no irrigated hayfields are crossed by the major transmission lines, the distribution line, location 1, interfered with irrigation. The rancher who operates this field wishes to use a wheel move system throughout the field. Such a system would be effectively blocked by the closely placed wooden poles of the distribution line. He has approached the local B.C. Hydro office about having the line moved. Although B.C. Hydro is willing to move the line, it insists on B.C. Hydro doing the work themselves. This policy adds several thousand dollars over the cost of a private contractor doing the work with the rancher using his own equipment to clear the right-of-way. The distribution line is over 10 years old but B.C. Hydro is reported to require the complete cost of replacement instead of depreciated value of the current line. The high labour cost of irrigating around the distributor will probably cause the rancher to eventually pay B.C. Hydro's price.

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[1] Source: Ministry of Agriculture and Food (Sept. 1982), Census of Agriculture Statistics, British Columbia, 1971 and 1981, Victoria, B.C.

Transmission lines at present do not interfere with irrigation on either of the other cultivatable land types. Problems may occur if the luvisolic soils of the plateau such as the Tyee soils are eventually irrigated. Organic meadows will continue to be subirrigated for the foreseeable future.

Several mitigation measures are available for the irrigated terraces. The best measure is to route transmission lines around areas where irrigation would increase the agricultural capability of land by several classes. Where this cannot be done, tower structures should be placed in such a way that standard wheel-move systems can be used. Matchstepping of towers on multiple transmission line routes would often help in this regard. Matchstepping would probably be a wasted expense over areas where irrigation would not be practiced. In areas where the above is not practical, special compensation and design information should be given to ranchers to enable them to use automatic irrigation systems that are compatible with the electrical lines. It is interesting to note from this case study that it is harder to develop a compatible irrigation system for electric distribution lines than for the major transmission lines. This is due to the lower conductors and closer spacing of poles of the distribution lines. Distribution lines are considerably cheaper to move and route around fields than major transmission lines.

The transmission lines were not found to alter drainage patterns or practices in the study area. Care should be taken to insure adequate culverts along construction and maintenance roads.

Soil Compaction and Erosion

Several locations in the study area show appreciable erosion. The most severe of these is along the terraces adjacent to Williams Lake Creek and Hawks Creek. In both of these cases, the good take by seed along the B.C. Hydro right-of-way appears to have reduced erosion compared with the same slopes outside of the right-of-way. Clearing may have led to some small scale erosion, however no significant loss due to erosion was noted by ranchers or on airphoto inspection. Rapid reseeding and contouring where necessary were effective mitigation measures for erosion.

Some loss of yield due to soil compaction around towers is evident from the air photos. The snow cover during the inspection of the study area prevented an estimate of this loss of yield. The loss on the rangeland such as on the Tyee soils is thought to be minor and out-weighed by the greater palatability of crested wheat grass on the right-of-way than the pinegrass off the right-of-way. Further studies are needed to quantify this potential loss of yields.

There are no hayfields on the main B.C. Hydro right-of-way. The Hargreaves soil association is coarse-textured and unlike the Tyee would not be subject to easy compaction. The major potential problem with the Hargreaves and similar soils is that the thin aeolian cap could be disturbed during construction. Soil compaction and disturbance around the wooden poles of the distribution line (location 1) did not appear to adversely affect the growing capability of the surrounding soil.

Increased Access

The removal of trees and construction of access roads along major transmission lines is known to increase access into remote areas. The study area is not a remote area. The entire area is used by resource users including range users, forestry companies and woodlot operators. The residents of the region use rangelands for a variety of recreational uses; hiking, all-terrain vehicles, snowmobiling etc. As long as the range is used only seasonally for grazing, the presence of the B.C. Hydro right-of-way does not appear to greatly increase conflicts between agricultural and other land uses. The major complaint is that gates are left open. This is a serious problem as it can result in loss of cattle and time. Cattle guards help to prevent this impact. When a major right-of-way is used as an access road by many users, a cattle guard should be installed. The $1500. to $2000. cost of such a cattle guard is an expensive outlay for most ranchers, especially if the rancher is only one of several users of the access road. The responsibility for deciding the location of guards and who is responsible for their cost and maintenance should be part of a coordinated management plan for the area.

An entirely different situation exists where the right-of-way is intensively used for agriculture. This situation exists at location 2 which is 3 km north of Williams Lake Creek on the B.C. Hydro right-of-way. In such a situation the level of conflict between agricultural and non-agricultural users is more intense. Cattle are present for a large portion of the year and recreational traffic could lower production. Field equipment is often left out and vandalism and theft may become a problem. Such areas benefit from controlled access. The right-of-way may increase the cost of controlling access in these situations. Increased fencing and lockable gates are needed. If recreational or forestry traffic is utilizing a right-of-way, alternate routes may have to be developed. Ranching in the study area is expected to grow in intensity over time. Pressure from the local population for access will also grow over time.

Although increased access into the study area is viewed by ranchers as a minor problem at the present time it may well grow into a major problem in twenty years. Several mitigation measures exist to lessen the impacts of improved access. The first is access planning. B.C. Hydro now produces plans for its own access for new rights-of-way. A general access plan is needed for all range units where access by different users creates conflicts. This is viewed as a continuing task because the need for control of access will change over time. Although B.C. Hydro needs emergency access to every tower site, this does not have to take the form of a maintenance road. There is little opposition to allowing a utility operator to have keys to locked gates and permission to drive over fields if there is just compensation. This controlled access system is relatively easy to set up where a new right-of-way crosses an existing field. Methods should be set up so that non-controlled access can become controlled access should the need arise. In the short term, mitigation measures such as cattle guards and reclamation of construction roads will alleviate most impacts. No mitigation method can replace courtesy on the part of all range resource users. Public education on correct uses of Crown land would be of great benefit.

Electrostatic and Electromagnetic Effects

Few shocks or other electrical effects were reported by ranchers in the area. Interference with TV signals was reported by one rancher. Other possible sources of TV interference such as distribution lines occur in the immediate area. In ranching areas, signal strengths are often weak. Satellite dishes are coming into use in the area and do not appear to be affected by transmission lines. Fences in the study area are reported to be sufficiently grounded. Some shocks are reported from vehicles operated under transmission lines.

The major impact of the electric field appears to be psychological. There is an undercurrent of worry. The ranching community is concerned that the fields around the transmission lines are somehow harmful to their cattle, themselves or their crops. They are unfamiliar with the preponderance of research that suggests that any such effects are negligible. Public education would probably help to alleviate their fears. No economically significant electrical effects were found in the study area except where distributor lines limited the use of reel irrigators.

3.2.3 Conclusions of Case Study #2 - Fraser Plateau

The presence of a major electrical transmission right-of-way was found to have a beneficial effect in the second case study. The major reason for this was the improvement to rangeland values provided by clearing of the right-of-way and seeding it with desirable range grasses. This provided ranchers with 10.4 Animal Unit Months (AUM's) of forage per year per kilometre of right-of-way. The crested wheat grass on the right-of-way was considered by ranchers to be preferable to the pinegrass off of the right-of-way in terms of its palatability, season of use and potential for weight gains. Several formidable obstacles were found to the utilization of this benefit. The first was the lack of skill on the part of the rancher in using techniques such as salting, fencing, and range riding to control cattle distribution. Other range management techniques had to be modified to optimize the use of the right-of-way. These included selective spraying of weeds. These management techniques would be required if the conifer cover was cleared for purposes other than a right-of-way and their cost does not outweigh the benefits of the increased forage. Several factors reduced the amount of range yields that could be realized from the right-of-way. These included a small amount of land loss, weed spread and yield loss due to soil compaction.

This positive picture changed abruptly on hayland. Since clipping is used to control weeds, tower bases become potential nurse areas for weeds. Land loss around tower bases increased with the size of farm machinery. There is little land loss if cattle graze around towers but if large mowers are used, the area lost around a tower could increase from $8m^2$ to over $100m^2$.

On areas which require irrigation, the negative impacts of electrical transmission lines increase another major step. The high labour cost of hand-move systems would far outweigh any benefits derived from clearing and seeding of the right-of-way.

Prompt reseeding of the right-of-way was reported by ranchers and was a successful mitigation measure in reducing weed spread and soil erosion. Other mitigation measures such as matchstepping and avoiding the ALR south of Hawks Creek were not undertaken but could have reduced the potential for impacts on irrigation of this benchland.

Another conclusion that could be drawn from the case study is that small electrical distribution lines can result in significant negative impacts to ranchers while not providing increased range values. Education was identified as a need in the study area. Special range management techniques were needed along the right-of-way. Providing information to farmers and ranchers on electric field effects is needed to allay fears and information on irrigation design around transmission lines is also necessary.

The stage of development of an agricultural area was shown to affect both the types and intensities of interactions with the electric transmission lines. Interference with ranching operations and impacts of access were not as much of a problem on the seasonally used portion on the right-of-way as in the surrounding range. Public education on proper recreational use of all rangelands is needed. On cultivated land, controlled access may be necessary. The linear development can be viewed as a joint user of the land it crosses. The fact of the right-of-way and its opportunities and requirements should be considered in Co-ordinated Resource Management Plans (CRMP's). Right-of-way operators should be included in CRMP's and other planning exercises.

It is important to note that the majority of ranchers interviewed would welcome the addition of the third 500 kV line because of the increased grazing. The addition of a third line would not require much more right-of-way as B.C. Hydro purchased enough right-of-way for the third line in most areas.

3.3 Conclusions to Phase II Case Studies

The two case studies provide an insight into the complex relationship between agriculture and linear developments. The range of interaction was found to differ greatly depending on the following factors:

1. Biophysical Factors

   the climate capability for agriculture of the area
   the ability of the soil to store water
   the ability of the soil to resist compaction
   the availability of irrigation water

2. Linear Development Factors

   the type and size of linear development
   the form and location of structures
   the relative position of different linear developments

3. Cultural Factors

   the availability of markets for specific agricultural products
   the attitudes of the agricultural community toward industrial developments
   the size and type of machinery and technology used
   the agricultural products grown
   the skill of the farmer or rancher

The two case studies represent only a small fraction of the situations that will be encountered along the existing and proposed linear developments identified in Phase 1. The results of these case studies should be put into a provincial context.

The following is a short review by linear development type of the major findings of the two case studies. The applicability of the results to proposed projects is also identified. The last section reviews common corridor findings. Section 3.4 gives recommendations for further studies arising from Phase II.

3.3.1 Electrical Transmission

Interference with automated irrigation equipment could be the most costly impact of electrical transmission on agriculture. When a line follows along a valley bottom such as in Case 1, the water climatic moisture demand is relatively constant along the line and soil water retention and the availability of groundwater determine the need for irrigation. Impacts are greatest on coarse-textured soils without high groundwater tables. On the Interior Plateau (Case Study #2) the majority of irrigation impacts occur along terraces along rivers.

Impacts are minimized if transmission lines avoid areas which show the greatest potential for irrigation. Impacts in the range of thousands of dollars per year per kilometre are possible. Major mitigation measures such as route modification, tower location, match-stepping and modification of irrigation systems are applicable to all areas of the province with large irrigation requirements. With these mitigation methods, the level of impacts can be reduced by several orders of magnitude. Electrical distribution lines were also found to cause serious interference with irrigation.

The presence of towers in a field led to several major negative impacts. Land loss of uncropped areas, time loss in avoiding towers, yield loss due to increased compaction around towers, yield loss due to increased weed populations, increased costs such as extra seed and fertilizer around towers, and possible damage of farm equipment from collisions with towers were all associated with the bases of transmission towers. These impacts were greatly influenced by the crops grown or the crops that could be grown. The crops which are grown are determined by the agricultural capabilities of the land, distance to markets and historical agricultural patterns. Land loss and related impacts were also influenced by tower type. The following table summarizes the case studies' findings of land loss. Other related impacts followed a similar pattern.

TABLE 3-3 Summary of Land Loss Along Electrical Transmission Lines

Case Study	Crop type	Linear structure	Land Loss m^2 per kilometre of transmission line
1	corn silage	500 kV lattice tower	345
1	corn silage	360 kV Metal H-frame tower	216
1	hay	500 kV Lattice tower	243
1	hay	360 Metal H-frame tower	60
1	pasture	500 kV Lattice tower	3
1	pasture	360 kV Metal H-frame tower	24
2	range forage	500 kV guyed V-tower	24
2	hay	500 kV guyed V-tower	300

Mitigation measures for land loss and related concerns can be grouped in order of preference:

- avoid high capability lands
- avoid areas where crops will be grown which require either frequent cultivation, large equipment or automated irrigation
- locate transmission towers along farm, field or natural boundaries
- minimize the base area of transmission tower
- change crops grown to those which are compatible with transmission lines yet which yield high returns

Unfortunately these measures were not followed in Case Study 1. The first mitigation measure was successful in greatly reducing impacts in Case Study 2.

Land loss due to substations is considerable. In both case studies, land lost to substations equalled or exceeded that lost to towers. Land loss and related impacts occur wherever towers cross cultivated land. Most of the area of the ALR crossed by electrical transmission lines would experience these types of impacts.

Three problems were noted with weed control. The most important was the nurse areas created for weeds under towers where mowers cannot reach. On intensively cropped land it cost $20. per tower per year to spray these areas. On less intensively cropped land weed populations are often left to invade surrounding areas, thus decreasing yields. The mitigation measures for this problem are similar to land loss.

The second problem is the temporary population of weeds just after construction. Farmers receive compensation for this. A major impact develops if new weed species are introduced into an area by transmission line development. Expansion of both knapweed and Canada thistle is a potential problem in northern, central and eastern B.C. along proposed routes. The third problem was continued weed population along rights-of-way in rangeland. This is a problem on all cleared pastures and does not appear to be consistently worse along rights-of-way.

Electrostatic and electromagnetic effects were significant concerns in Case Study 1 due to the possible contributory effect of tingle voltages and shocks. Other effects such as noise and radio interference were only inconveniences. In the Williams Lake case study, only inconveniences such as TV interference were reported but some uneasiness about possible biological effects was expressed.

Increased access was not viewed as a problem in the Lower Fraser Valley. In the Williams Lake area conflicts between resource users occurred throughout the study area. Although problems such as cattle gates being left open occurred along the right-of-way, it was hard to separate effects of the right-of-way from background effects. Control of access is needed in cultivated areas. In developed areas of the province such as the Lower Fraser Valley, such control is taken for granted while in remote areas access is often taken for granted. More public education on considerate use of Crown Range is needed. Some additional use of cattle guards and controlled access gates may be needed.

Soil compaction along transmission lines was noted near towers on fine-textured soils in Case Study 1 and along paths following the right-of-way on luvisolic soils in Case Study 2. Such soil compaction probably lowered yields in both cases. The largest positive impact of transmission lines was noted in the Crown Range areas of Case Study 2. In these areas the right-of-way saved ranchers $1000./ha in clearing costs and added grazing of 0.8 AUM per hectare per year of cleared right-of-way. The 130m wide right-of-way thus generated an additional 10.4 AUM's per kilometre. This positive effect was felt to be sufficient to more than balance the negative effects on rangeland. For this reason, the ranchers welcome the additional line that is proposed for the right-of-way. Much of the land that is along proposed electrical transmission rights-of-way is covered by coniferous forest and has an improved agricultural capability rating of classes 4, 5, or 6. The increased grazing capacity generated from clearing of the right-of-way will expand beef herds and provide ranchers with increased incomes on most of this land. Eventually agriculture may expand in the area to the extent that this rangeland is cultivated. At such time the balance of negative and positive impacts would shift. For this reason some assumptions as to the time frame of agricultural development must be made in order to predict the future impacts of a proposed electrical transmission line. Such predictions are necessary when designing mitigation measures.

3.3.2 Pipelines

Pipelines were found to have less interaction with agriculture than electrical transmission lines. The most serious impact is continuing yield loss on fine textured soils along the trenchlines. Such losses can amount to \$500. per kilometre per year for corn silage. Drainlines could lower this loss in some situations. The cost of installing drainlines may be greater adjacent to pipelines. Since the impacts of pipelines are closely related to fine soils, the Peace Region with its fine-textured soils and large number of existing and proposed pipelines may be an area to study in greater detail. Vancouver Island and the Lower Fraser Valley may also be areas of concern.

3.3.3 Railways

The B.C. Hydro Railway was a major source of land loss in Case Study 1. This single track railway removed 3500m^2 from cultivation per kilometre. Double tracking of the CN mainline is therefore a concern to agriculture as the line traverses many agricultural areas. Since railways can increase land fractionation, the location of new railways should insure economically sized fields and crossings for farm animals and equipment.

3.3.4 Roadways

Inspection of aerial photographs of the Sumas Valley show roadways as the largest source of land loss in the area. In case study 2 the Cariboo Highway resulted in loss of agricultural land rated as class 2 with irrigation. In either case, roads were needed to give farmers access to areas. Major highways alienate more agricultural land than is necessary to provide access. Roads can result in land fractionation. In case study 2 the Cariboo Highway resulted in direct land loss and increased costs but not additional land loss due to land fractionation. Agricultural impacts should be considered when planning new roads and widening or realigning existing ones.

Common Corridor Concerns

The relationship of linear developments was found to affect their interaction with agriculture. Farmland could be divided into areas too small to be farmed efficiently. This occurred between a railway and dike in Case Study 1. While land fractionation can occur between two exclusive use rights-of-way, a similar problem can occur between shared use rights-of-way such as a pipeline and transmission line as in Case Study 1. In this case, a farmer could not expand barns because of building restrictions on rights-of-way to either side of an existing barn. Placement of linear developments together could substantially minimize such impacts. Another situation of planning rights-of-way together was found in case study 2. By using a wide right-of-way for several electrical lines, cattle management problems were reduced. Group rights-of-way also decrease the cost of weed control measures. Interference with irrigation can be lessened in some situations by common corridors. Another advantage to common corridors is the increased efficiency of managing a farm crossed by several rights-of-way if only one route is used. In valleys such as the Sumas Valley where several linear developments are forced to follow similar routes, the use of a common corridor should always be investigated. Common corridor studies may also be needed on the east side of Vancouver Island and the east side of the Okanagan Valley.

In general, common corridors will intensify the impact on one area while reducing the total impact. This is advantageous only where the proposed common corridor has a lower agricultural capability than the non common alternative corridors. Common corridors may greatly increase the negative impacts of linear development if they force linear developments onto higher capability land.

3.4 Recommendations for Further Study

During the preparation of the two case studies, several questions were raised which could not be answered due to time and budget constraints of the current study. The following are recommendations for studies needed to complete the agricultural/linear development picture.

1) A study of alteration of yields along pipelines and electrical transmission lines. Several situations were reported by some farmers which affect continuing yields on rights-of-way. These included:

   - altered drainage and subsidence above pipeline trenches
   - compacted areas immediately around transmission towers
   - weed infested areas extending several tens of metres out from transmission tower bases

   This type of study would contribute to more accurate compensation and a better assessment of proposed project impacts. Soil types probably play a key role in determining alteration of yield and should be considered in the study. Key regions identified in Phase 1 such as the Peace Region for pipelines and the Cariboo and Thompson Regions for electrical transmission lines should also be covered by a yield study. The results of such a study should be published to acquaint both farmers and linear developers with the results.

2) Weed control methods around transmission tower bases need to be evaluated for effectiveness, economy and safety. Farmers who have towers in their fields should be supplied with recommendations for weed control measures and techniques. Manual methods such as hand mowing should be evaluated along with chemical measures.

3) Irrigation is being automated at a rapid rate throughout the province. Electrical transmission towers interfere with many

wheel-move and reel type irrigation systems. Many alternate systems which may be compatible with transmission lines are available both in Canada and the United States for example reciprocating wheel move systems. A study is needed to evaluate irrigation systems compatible with transmission lines in terms of their capital cost, effectiveness, labour and operating cost.

4) The possible effects of roads and railways on natural subirrigation and groundwater flow were not evaluated during this study. Subirrigation is important in many of the key growing areas in the Lower Fraser Valley, the Pemberton Valley and Vancouver Island. A pilot study of watertable levels is needed to determine the importance of this phenomenon to agriculture.

5) Tingle and stray voltages in dairy barns are significant problems for the dairy industry, both in B.C. and in other areas. Linear developments are probably only involved in a minor way in problems with tingle voltage. A larger research effort into 'electrical pollution' and tingle voltage appears to be warranted.

6) An independent review of B.C. Hydro's upcoming standards for audible noise, radio interference and field strength is needed. The results should be publicized to allay fears of many persons in the farming community of the electrical field effect of transmission lines.

7) Distribution electrical lines can have serious impacts on the fields they cross. They can block irrigation equipment and result in land and time loss. Policies and regulations governing distribution electrical lines should be reviewed.

8) The relative merits of different transmission tower designs on farm land should be compared. The basic question that needs to be answered is does the benefit derived from a given tower design justify its additional cost?

9) Skill and special range management techniques are needed to maintain good animal distribution on forested ranges crossed by transmission lines. While some ranchers have learned these techniques, others would benefit from more information on the subject. This is particularly important in locations where a new right-of-way is to be established. The proposed transmission lines west of the Fraser River in the Cariboo are such a situation.

10) Specific grounding and wiring procedures for electric fences should be made available to farmers along electrical transmission rights-of-way.

11) A case study should be completed in a remote area which is at the fringe of a ranching area. Such a study should address the agricultural development opportunities associated with the electric transmission proposals for the western Chilcotin and northwestern B.C.

12) The effect of new highways and industrial roads in ranching areas on range management has received little or no research. Research into this area is needed to develop Environmental Procedures for planning and operating highways and industrial roads.

4.0 PHASE III - POLICY REVIEW

4.1 Introduction

The number and extent of linear projects in British Columbia have rapidly expanded over the last 30 years. Appreciation of how these projects interact with other land users and the natural environment has also grown over the years. Since the 1950's a complex system of governmental controls and industrial self-regulation has evolved to address concerns raised by linear projects. The rationale for this regulation is that optimum decisions on project location and design can be made only if all benefits and costs of a project are taken into account. Consideration of the natural environment and alternate resource uses which are external to the prime objectives of linear project developers are especially important in British Columbia where most of the land is held by the Crown.

The history of incorporating social, environmental and alternate use criteria in project planning has gone through a number of phases in B.C. In the 1940's and early 1950's the only clear controls arose from the legal necessity to compensate landowners harmed by linear projects. The environmental movement of the 1960's led to legislation requiring a review of environmental impacts before a project was undertaken. Impact reports concentrated on the effects on fish and wildlife species at first, then evolved into multidiscipline studies that considered social, economic and environmental issues. The impact review process was initially directed at the decision to proceed or not to proceed with a project. In the 1970's and early 1980's the consideration of social and environmental issues has become integrated with economic and engineering concerns. Impact review processes are now often aimed at recommending mitigation measures as well as assessing potential environmental damage.

Agricultural concerns, ideally, are identified early in project planning with other environmental and resource issues. Routes and designs can be modified in preliminary stages so that reviewers consider projects that are already heavily mitigated. Greater emphasis has also been placed on monitoring and surveillance once a project has begun operations. There has been an evolution from compensation alone to impact management where all effects of a project are addressed throughout the life of the project.

This modern concept of impact management forms the basis for reviewing environmental policies by both the government and private sectors. Current federal, provincial and proponent policies are described for each type of linear project. The effectiveness of these policies in managing opportunities and risks to agriculture is evaluated in light of Phases 1 and 2 of this study. Policy changes are recommended where they improve the management of agricultural impacts due to linear projects. Where recommended changes could affect other environmental or resource interests, the concerns of these interests are given. The entire process from project inception to operation is reviewed for both existing and planned projects.

Information on existing policies was gathered from three sources. The first involved interviews of personnel of the Federal Environmental Assessment Review Office, National Energy Board, Environment Canada, B.C. Ministry of Energy, Mines and Petroleum Resources, B.C. Ministry of Environment, and the B.C. Ministry of Agriculture and Food. These people are noted in the Contact List in Appendix 5a. The second source was a review of government and industry documents shown in Appendix 5b. The last source of information made use of the questionnaires answered by linear operators during Phase 1.

4.2 Electrical Transmission

4.2.1 Current Regulation

Federal Regulation

There is currently little federal regulation of electrical transmission projects in B.C. and only one regulatory agency directly responsible for reviewing proposals: The National Energy Board (NEB). The NEB was established in 1959 by the National Energy Board Act and was given the authority to review energy projects. Unlike pipelines, electrical transmission lines are defined by the NEB as only those individual power lines leading to or crossing an international border. The B.C. electrical grid system as a whole is not regulated by the NEB. The following are considered by the NEB to be international power lines in B.C.:

B.C. Hydro

- o Ingledow Substation (Vancouver) to Custer Substation (Washington State). Two 500 kV circuits.
- o Cranbrook to Boundary Substation, Nelway, (Washington State). One 230 kV circuit.

Cominco (operated by West Kootenay Power and Light)

- o Waneta to Boundary Substation, Nelway, (Washington State). One 230 kV circuit.

For these power lines the NEB follows a simple review process covering only new lines between existing substations and an international border. During the process, an application to construct a new line includes general information on land capabilities and uses, including agriculture. After a public hearing the NEB assesses the application and, if approved, grants a Certificate of Public Convenience and Necessity. Terms and conditions can be added to this certificate by the NEB to satisfy concerns for impact mitigation and compensation. Normally, the line is inspected once after construction to ensure that the terms and conditions have been met.

The NEB process and federal jurisdiction in general takes precedence over provincial acts. No recent applications for international power lines have been made in B.C.; there are no examples of what roles would be played by provincial acts such as the Utilities Commission Act and the Agricultural Land Commission Act. The NEB operates in Ottawa and, according to personnel contacted in this study, has only a sketchy knowledge of the provincial Utilities Commission and little knowledge of the Agricultural Land Reserve or agricultural issues in British Columbia.

Provincial Regulation

Regulation of new high voltage (over 500 kV) electrical transmission lines is evolving rapidly in B.C. under the Utilities Commission Act. Little regulatory activity is evident dealing with smaller transmission and distribution lines. Little remedial action is being taken to address impacts caused by older transmission lines constructed prior to environmental regulation.

Provincial regulation of electrical transmission projects falls into two categories. The first includes the environmental review processes discussed below. The second category comprises the special purpose legislation described in the subsequent section.

There are three basic environmental review processes followed in British Columbia. Large energy projects deemed to be significant for the province are regulated by the Utilities Commission Act through the Energy Project Review Process. Projects of moderate size that cross regional boundaries can be reviewed by the Ministry of Environment under the Guidelines for Linear Development. Smaller projects of mostly regional significance were reviewed by Regional Resource Management Committees before these committees were discontinued. Both the Guidelines for Linear Development and the Regional Resource Management Committees were established by the Environment and Land Use Act (RS 110, 1979). The following is a synopsis of each of these review mechanisms.

Energy Project Review Process. The rapidly developing B.C. Energy Project Review Process (EPRP) forms the basis for most regulation of electrical transmission projects in the province. Under the Utilities Commission Act (RS 60, 1980), transmission lines are regulated projects if they involve operating voltages of 500 kV or more. Smaller lines are also regulated if they connect to new power plants of 20 MW or higher, or involve electrical use of 3PJ (95 MW of continual use). An energy project of any kind can be regulated if directed by the Lieutenant Governor in Council.

The Energy Project Review Process normally begins with a prospectus, prepared by the project proponent, giving a general project description and schedule, project rationale and a description of proposed studies. The prospectus is reviewed by the Energy Project Coordinating Committee and appropriate working committees.

There are three working committees: Environment, Resources and Land Use, Social and Economic, and Energy, Economics and Finance. The B.C. Ministry of Agriculture and Food, is represented by the Farmland Resources Branch on the Environment, Resources and Land Use Committee. It is through this working committee that agricultural concerns are first communicated to the project proponent. The Farmland Resources Branch may inform the Agricultural Land Commission and regional field staff of the project at this time.

The next step is the Preparation of a Preliminary Planning Report by the proponent. A key component is an analysis of alternative routes and locations. Also included in this report are the following: a preliminary procurement plan, terms of reference for detailed environmental, socio-economic and project justification studies, a description of a public consultation program, and a list of approvals, licences and permits required. The preliminary planning report is reviewed by the EPCC and Working Committees. This review is more formal than that of the prospectus. A working committee could identify areas where either the inventory or analysis is in their opinion deficient for route selection purposes. They could ask that additional studies be undertaken to cover areas of dispute. Agencies, in particular, the B.C Agricultural Land Commission may also make known their preferences for a most desired route or corridor. Normally at this stage a route is a corridor several kilometres wide and, as such, often contains land of widely varied agricultural capability and development. As the company has not made application at this time, recommendations for choosing a particular corridor are only recommendations to the company.

Usually the next step is to use the preliminary planning report as a basis for public consultation, which is conducted on a project-wide basis. All aspects of a project are discussed throughout the project area. Local residents may form impact committees and/or municipal governments may represent local views. Ideally, the public consultation continues until a line is satisfactorily completed and operating. Objections to a line can be voiced by individual farmers at public meetings.

The first formal and legally necessary portion of the Energy Project Review Process is the Application. B.C. Regulation 388/80 pursuant to Section 18 of the Utilities Act states that an application should contain:

> "... identification and preliminary assessment of any impacts by the project on the physical, biological or social environments, and proposals for reducing negative impacts and obtaining the maximum benefits from positive impacts."

The application documents are formally reviewed for compliance with the regulations. Once this is done and the proponent clears up any deficiencies, the application is forwarded to the Minister of Energy, Mines and Petroleum Resources. This Minister, with the concurrence of the Minister of Environment, may proceed with the application in any one of three ways. Under Section 19(1)(a), the application can be referred to the Utilities Commission with the ultimate decision being made by Cabinet. Under Section 19(1)(b), the application can be dealt with by the Commission as an application for a Certificate of Public Convenience and Necessity. Under Section 19(1)(c), a project can be exempted from provisions of the Utilities Commission Act. In any case, terms and conditions can be included in:

> "An Energy Project Certificate under a Certificate of Public Convenience and Necessity or an Energy Operation Certificate or an Exemption Order."

Since it would be unlikely that an agricultural concern along a transmission line would be sufficient to cause the failure of an application, the types and implementation of terms and conditions accompanying a project's approval are a key to agricultural impact management.

The following is a short review of the development and implementation of Terms and Conditions for Kelly Lake Substation to Nicola Substation 500 Kv Transmission Line. This review is provided because the implementation section of the Energy Project Review Process is determined more by precedent than by documentation.

> On May 6, 1981, B.C. Hydro and Power Authority made application to build the Kelly Lake-Nicola 500kV line.
>
> The application was reviewed under the Energy Project Review Process and it was determined that the project would have minimal environmental and socio-economic impacts which could be managed through terms and conditions (a clear statement of the Impact Management philosophy).
>
> On September 8, 1981, the Agricultural Land Commission approved the proposed route subject to a list of conditions. This approval came under the Agricultural Land Commission Act after a lengthy process described in the folowing section.
>
> On October 29, 1981, the Minister of Energy, Mines and Petroleum Resources, with the concurrence of the Minister of Environment, granted an exemption to the project under Section 19(1)(c) subject to terms and conditions.

For the Kelly Lake-to-Nicola line, the terms and conditions were instrumental in improving agricultural and linear project interactions. The key terms are summarized below:

1) A project steering committee was established to ensure compliance, including representatives from the Ministry of Agriculture and the Thompson-Okanagan Regional Resource Management Committee.

2) This committee had the authority to set clearing specifications, subject to the approval of the Ministry of Energy, Mines and Petroleum Resources.

3) B.C. Hydro was instructed to implement measures necessary for soil conservation, revegetation and noxious weed control. Such measures are outlined in the Guidelines for Linear Development on Agricultural Land (Ministry of Agriculture and Food) and the Weed Control Act (RS 432, 1979).

In February, 1983, a route modification was granted to B.C. Hydro which added the following conditions:

1) The project steering committee was empowered to impose additional conditions on the construction and operation phases to ensure protection of environmental and social resources.

2) The land use mitigation measures identified in the B.C. Hydro's environmental review were incorporated into the condition of the order.

3) The route modifications were also approved by the Agricultural Land Commission.

Large scale airphoto mosaic maps were included in B.C. Hydro's environmental report and clearly showed the position of sensitive areas and the location of proposed mitigation measures along the entire route. These index maps will guide the Environmental Officer supervising the construction of the line. In addition to working with the Project Steering Committee, the Environmental Officer will also report to the Surveillance and Monitoring section of the Planning and Assessment Branch of the Ministry of Environment.

In general, the persons directly involved with the Energy Project Review Process felt that it is rapidly maturing and will be successful in mitigating or compensating all social and environmental impacts in the near future.

Guidelines for Linear Development. Moderately sized electrical transmission projects such as transmission lines operating below 500 kV can be reviewed under the B.C. Guidelines for Linear Development (Victoria, 1977). These guidelines predate and set down the basic steps for the Energy Project Review Process. Figure 4-1 shows the assessment and planning review procedure under these guidelines.

For electrical transmission projects, the Guidelines for Linear Development have been superseded to some extent by the Energy Project Review Process. Enforcement and supervision of the guidelines would probably be more efficiently managed as a project regulated under the Utilities Commission Act.

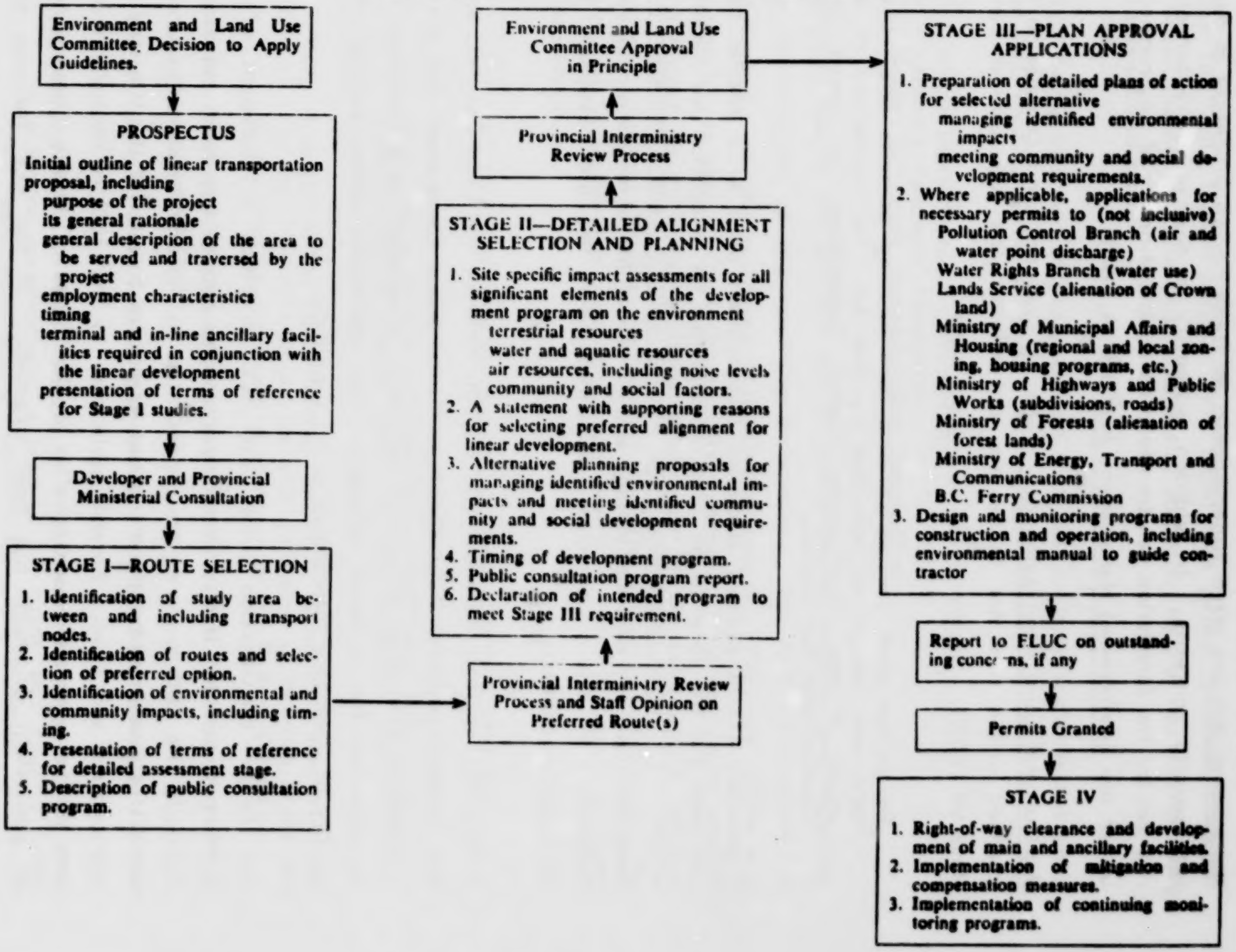
Regional Resource Management Committees. Electrical transmission lines that are not regulated under the EPRP or the Guidelines often require various local permits to cross the Agriculture Land Reserve, Crown land, streams or municipal properties. If significant concerns are raised by local farmers or others, the Regional Resource Management Committee (RRMC) may be asked to review the development. RRMCs were formed under the Environment and Land Use Act.

In general, the RRMC is a formalized form of interagency referral at the regional level. Because there is a lack of public documentation on these committees, only a tentative investigation was made for this study. There appear to be significant differences in the working arrangements of each RRMC. The influence and effectiveness of the RRMCs is growing rapidly in many regions. It appears that district field staff could refer any concern about a linear project to the regional director and hence to the RRMC. If an RRMC were unable to resolve a problem, it would be referred to the Ministry involved.

Special Purpose Legislation

In addition to the three basic review mechanisms discussed above, the provincial government implements a number of special acts that address the preservation of the agriculture industry. Special purpose acts such

Linear Development Assessment and Planning Review Procedure



Environment and Land Use Committee. Decision to Apply Guidelines.

PROSPECTUS

Initial outline of linear transportation proposal, including
- purpose of the project
- its general rationale
- general description of the area to be served and traversed by the project
- employment characteristics
- timing
- terminal and in-line ancillary facilities required in conjunction with the linear development
- presentation of terms of reference for Stage I studies.

Developer and Provincial Ministerial Consultation

STAGE I—ROUTE SELECTION

1. Identification of study area between and including transport nodes.
2. Identification of routes and selection of preferred option.
3. Identification of environmental and community impacts, including timing.
4. Presentation of terms of reference for detailed assessment stage.
5. Description of public consultation program.

Provincial Interministry Review Process and Staff Opinion on Preferred Route(s)

STAGE II—DETAILED ALIGNMENT SELECTION AND PLANNING

1. Site specific impact assessments for all significant elements of the development program on the environment
   - terrestrial resources
   - water and aquatic resources
   - air resources, including noise levels
   - community and social factors.
2. A statement with supporting reasons for selecting preferred alignment for linear development.
3. Alternative planning proposals for managing identified environmental impacts and meeting identified community and social development requirements.
4. Timing of development program.
5. Public consultation program report.
6. Declaration of intended program to meet Stage III requirement.

Provincial Interministry Review Process

Environment and Land Use Committee Approval in Principle

STAGE III—PLAN APPROVAL APPLICATIONS

1. Preparation of detailed plans of action for selected alternative
   - managing identified environmental impacts
   - meeting community and social development requirements.
2. Where applicable, applications for necessary permits to (not inclusive)
   - Pollution Control Branch (air and water point discharge)
   - Water Rights Branch (water use)
   - Lands Service (alienation of Crown land)
   - Ministry of Municipal Affairs and Housing (regional and local zoning, housing programs, etc.)
   - Ministry of Highways and Public Works (subdivisions, roads)
   - Ministry of Forests (alienation of forest lands)
   - Ministry of Energy, Transport and Communications
   - B.C. Ferry Commission
3. Design and monitoring programs for construction and operation, including environmental manual to guide contractor

Report to ELUC on outstanding concerns, if any

Permits Granted

STAGE IV

1. Right-of-way clearance and development of main and ancillary facilities.
2. Implementation of mitigation and compensation measures.
3. Implementation of continuing monitoring programs.

FIGURE 4-1

as the Agricultural Land Commission Act, the Water Act, and the Waste Management Act are often superimposed on these review processes to deal with specific concerns. In addition, authority to deal with any concern not met by the legislation can be reviewed by the Ministry of Environment under the Environment Management Act (RS 14, 1981).

Agricultural Land Commission Act. The Agricultural Land Commission is charged under this Act to set up and monitor the Agricultural Land Reserve (ALR). Section 15(2) of the act states:

> No person shall use agricultural land for any purpose other than farm use, except as permitted by this Act, the regulations or an order of the [Agricultural Land] Commission, on terms the Commissioner may impose.

Regulation 313/78 defines electrical transmission lines as a special use and sets out the form to be used in applying for a special use permit. Unlike the Utilities Commission Act, the Agricultural Land Commission Act does not state any minimum voltage and all new rights-of-way are reviewed regardless of site. No clear guidelines exist for the resolution of interagency conflicts.

Except for the Interpretation Act, the Environment and Land Use Act, and the Pollution Control Act; the Agricultural Land Commission Act takes precedence over other Provincial statutes. Application form (Schedule F) is unsuited for a linear project. No guidelines exist stating the quality of inventory information to be supplied.

For larger transmission lines, the ALC prepares a statement of a preferred corridor if a preliminary planning report has been released. Normally the ALC concerns are represented on the Environment Resources Land Use Committee by the Farmland Resources Branch of the Ministry of Agriculture and Food. Formal application to the ALC is normally made late in the approval process, after a Certificate of Public Convenience or equivalent document has been granted. If the ALC believes the proposed project is compatible with agricultural purposes, an approval will be granted.

The Agricultural Land Commission had considerable input into the Kelly Lake to Nicola transmission. This input was primarily made directly between the Agricultural Land Commission and B.C. Hydro, not through the Utilities Commission.

After being informed of the proposed Kelly Lake-Nicola transmission line, the ALC contacted the following ranching associations:

Nicola Stock Breeders Association
Ashcroft Ranchers Association
Upper Hat Creek Stockbreeders Association

After reviewing the Stage I and II environmental reports and receiving recommendations of the ranching associations, the ALC recommended a realignment of the proposed transmission route. The new route was acceptable to both B.C. Hydro and the ranchers. The new route avoided the higher capability agricultural lands near Nicola Lake where hay was grown. Subject to this realignment and the following conditions, the proposed transmission line was approved by the Agricultural Land Commission.

(1) the new line paralleling existing lines wherever possible;

(2) the eastern end of the line area Nicola Lake should comply with what was agreed to between B.C. Hydro and the Nicola Valley Ranches as it avoids much of the irrigated and cultivated fields in the area;

(3) line should be kept in scrub timber or timbered areas, wherever possible, as this would be less damaging to grazing areas and would provide increased grazing once the R/W was cleared;

(4) transmission towers are not to be located in any irrigated or cultivated fields;

(5) line should follow property boundaries through private cultivated lands;

(6) construction roads should be kept to a minimum. Furthermore, prior to construction, a plan of all roads and staging areas, their use, standard of construction and eventual disposition should be prepared and made available to the B.C. Forest Service and ranchers holding grazing permits in the area. In this way, Hydro's activities could be co-ordinated with possible range improvement projects;

(7) access road construction should be kept to a minimum and maximum use should be made of existing access roads. These roads should be carefully selected and upgraded for multi-purpose use. A continuous multi-purpose road is not recommended. The Commission would also encourage the use of helicopters wherever possible;

(8) B.C. Hydro or contractor to secure permission from appropriate crown agencies and/or property owners for permission to use existing roads or to build new roads;

(9) B.C. Hydro to ensure any damage to fences, gates, cattle guards, culverts and bridges is avoided or promptly repaired. B.C. Hydro should also be responsible for the activities of its contractors in assuring all facilities are kept in good condition;

(10) B.C. Hydro to maintain control of noxious weeds such as knapweed on its R/W;

(11) B.C. Hydro to ensure that revegetation of disturbed areas takes place immediately, otherwise the rapid invasion of the disturbed area by noxious weeds could take place. Hydro should also endeavour to improve the grazing capability of the cleared R/W by soil preparation and seeding;

(12) drift fences should be installed to prevent the drift of cattle from one range unit to another.

The effect of these conditions was to greatly reduce the potential negative impacts on agriculture of the proposed transmission line, both within the Agricultural Land Reserves and on the rangelands outside of the Reserve. The Commission also acted as a substantial link between the ranchers' associations and B.C. Hydro. The ALC has no normal inspection procedures and relies on complaints by the ranchers and Regional District for follow-up.

Other Special Purpose Acts. The following is a short review of the many provincial statutes that may affect the interaction between electrical transmission projects and agriculture. The Soil Conservation Act forbids the removal of soil or the placement of fill in the Agricultural Land Reserve without permission from the Agricultural Land Commission. The Weed Control Act requires the control and eradication of noxious weeds growing in the Province. The Water Act requires permits for the use, diversion, and storage of water, the alteration of streams or channels, and the operation of works in and around waterbodies. The Range Act includes provision for the use of Crown range, such as control of livestock and revegetation. The Waste Management Act controls the emission or discharge of effluents and contaminants onto the land or into water or air. The Pesticide Control Act requires permits for the use of pesticides and herbicides, including those used along electrical transmission rights-of-way.

4.2.2 Conclusions and General Recommendations

Electrical transmission lines do not constitute a threat to agriculture in B.C. The total amount of land that has been permanently alienated by electrical transmission lines in the Agricultural Land Reserve is on the order of 200 ha. Electrical transmission lines have probably put more land than this into non intensive agricultural production by absorbing land clearing costs along rights-of-way. Several impacts were found where transmission towers significantly interfered with agricultural operations over areas much larger than the rights-of-way. Mitigation measures are available to greatly lessen many of these. However, in the past these mitigation methods were not often employed. The current system of regulation of major energy energy projects in B.C. by the Utilities Commission is geared for impact management. The Agricultural Land Commission reviews all transmission projects that cross the Agricultural Land Reserve and can stipulate impact management procedures with the Reserve.

The Energy Project Review Process was found to be complete and efficient for the management of impacts to agriculture. Three areas of general improvement can be identified. The first area involves electrical transmission lines that were not reviewed under the EPRP because they were either too small or constructed before the process was in place. The second area which could be improved concerns the strengthening of agricultural input into the review process. The third area deals with information flow; the EPRP is new and many of the details of the process are known only to a few people.

The following recommendations are aimed at improving the relationship between transmission lines and agriculture:

> RECOMMENDATION 1 - Communications between the Agricultural Land Commission and the EPRP working groups should be formalized to share information and avoid conflicts.
>
> RECOMMENDATION 2 - A brochure should be prepared to briefly outline the different regulatory structures for all linear and non-linear projects.
>
> RECOMMENDATION 3 - Agricultural field officers should be informed of proposed projects, potential impacts and mitigation measures applicable to their areas.

The Guidelines for Linear Development on Agricultural Land (B.C. Ministry of Agriculture) provided a basic framework for including agricultural mitigation measures into the terms and conditions of the Kelly Lake-Nicola 500 kV transmission lines. The following recommendations are aimed at building on this success.

> RECOMMENDATION 4 - The Guidelines for Linear Development on Agricultural Land should be updated and expanded on a regular basis. In particular, separate sections should be made for different types and sizes of projects. More emphasis should be placed on mitigation measures where avoidance is not possible due to concerns for other resources.

Interviews with linear project officers revealed a growing understanding of the needs and wishes of the agricultural industry. Westcoast Transmission Company Ltd. has developed an Environmental Procedures Manual for use in applications, contracts, and inspections of pipelines. B.C. Hydro is in the process of preparing a similar document.

> RECOMMENDATION 5 - The government should encourage self-regulation by linear project operators as much as possible. Environmental procedure manuals are an important tool for linear project self regulation and should therefore be encouraged. These manuals should become part of the tendering documents so construction contractors are bound by them.

Small projects including distribution electric lines were found to have significant impacts on agriculture. These projects are only regulated by the Agricultural Land Commission.

> RECOMMENDATION 6 - A follow-up inspection by the Farmland Resources Branch after construction of approved project should be a regular procedure, not only to insure compliance but also to improve mitigation methods for future projects.

> RECOMMENDATION 7 - The Farmland Resources Branch should research the impacts and mitigation methods for constructing and operation of electrical transmission lines that are not regulated by the Energy Review or Linear Guidelines. Linear project operators should include suitable procedures for these small lines in their Environmental Procedure Manuals and day to day operation. Site specific problems should be referred to the operators first, then to the Agricultural Land Commission.

> RECOMMENDATION 8 - When a new transmission line is proposed to run adjacent to or close to existing transmission lines, the agricultural impacts of the existing line should also be investigated and mitigation measures recommended where applicable.

4.2.3 Impact Management Recommendations

The following is a review of the management of negative and positive impacts of transmission lines, the effectiveness of current regulations, and the success of the regulatory agencies. Because agricultural concerns are unlikely to halt linear development in B.C., the impact management approach is seen as a reasonable method of protecting agricultural resources. The agricultural industry is also a heavy user of electric power and is generally cooperative with other resource users.

Building Development

As shown in Case Study 1, the creation of an electrical transmission line right-of-way can restrict agricultural building development. Since this type of impact can occur well after a line has been built, it is important to avoid areas where intensive *agricultural development is expected. The Guidelines for Linear Development on Agricultural Land encourages linear projects to locate outside the ALR. Because this guide does not consider other resources, this is an overly simplistic approach. Forestry or other concerns may indicate that the ALR is a preferred route in some instances. In addition, some areas of the ALR are unsuited for intensive agriculture and may even benefit from transmission line development (as in Case Study 2).

> RECOMMENDATION 9 - The Guidelines for Linear Development on Agricultural Land should include guidelines similar to the following.
>
> Electrical transmission line rights-of-way should avoid areas where intensive agriculture has developed or is likely to develop where the right-of-way would restrict such development. This includes the construction of additional lines in an existing right-of-way.
>
> Where this is not possible, mitigation measures such as the use of common corridors, and double circuit towers should be followed.
>
> Electrical utilities should consider relocation of existing major transmission lines where they restrict intensive agricultural building development, if new rights-of-way are economically justified.

In addition, the Guidelines for Linear Development on Agricultural Land should be supplied to district and regional agricultural officers, electrical utilities, the NEB, and other interested parties. The Guidelines should also apply to land outside the ALR as well. For example:

> "Greenhouse areas...greenhouse development warrants protection although soil is less of a siting factor for greenhouses than is location near a major market. Greenhouses can not be built on a right-of-way. A greenhouse development outside the ALR may be more seriously impacted by a transmission line than hayland in an ALR"

Land Acquisition

Another problem regarding agriculture building development occurs when a

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* intensive agriculture includes cropland which is subject to frequent field operations (e.g. 7 operations a year). Cattle areas such as feedlots where cattle are kept for extended periods, irrigated haylands and areas immediately around agricultural buildings. Non intensive agriculture includes rangelands, non irrigated hayland and pasture.

utility purchases more land than is immediately required for a substation with an eye to future expansion. Such reserves for expansion may be very practical. While such areas can be rented to farmers for cultivation until they are needed, no development of structures is normally allowed.

> RECOMMENDATION 10 - Where land is purchased in excess of the immediate needs of project and agricultural development is thus restricted, the appropriate review agency should be informed of this restriction and the reasons for it.

Land Fractionation

Land fractionation was found to occur where two non agricultural users surrounded small areas of agricultural land thus increasing production costs.

> RECOMMENDATION 11 - The Guidelines for Linear Development on agricultural land should include a guideline such as the following. Substations and capacitor stations should be either located adjacent to or away from other exclusive land uses such as road and railways so as not to result in land fractionation.
>
> Where this is not possible or practical, mitigation measures such as the development of the land for crops compatible with cultivating a small area should be undertaken.

Land Loss

Land loss along electrical transmission rights-of-way was found to have two causes. The first was the loss around the tower base. Depending on the crop and cultivation practice, the areas involved ranged from slightly more than the tower base to more than twice the tower base area. The second impact is the land lost due to substation and similar installations. Loss due to transmission tower was in the magnitude of 0.5% of the right-of-way. (345m^2 per kilometer of a right-of-way 64m in width). Provincially this would total about 71 ha in the ALR. Land loss in the ALR due to substation is in the same order of magnitude at 100 ha. More emphasis should be placed on substation size and location during the entire review process. The Guidelines for Linear Development on Agricultural Land do not mention substations. The location of substations takes on more importance due to their influence on future transmission line location.

The case studies illustrated the fact that the impact of land loss is dependent on the suitability of the land for high value crops as much as on the total amount of land lost. The following recommendations are aimed at both reducing the land lost to substation and transmission towers and the value of the land lost to agriculture.

> RECOMMENDATION 12 - The Guidelines for Linear Development on Agricultural Land should state that substations and similar installations should not be located on land which is suitable for intense cultivation. Normally this would apply to land with an improved land capability rating of Class 3 or higher (according to the BCLI system) which is not distant from current or future markets. Often such land is in the ALR.
>
> RECOMMENDATION 13 - Due to the strategic importance of substation siting in the location of future transmission lines, the Farmland Resources Branch of the Ministry of Agriculture and Food should hold regular meetings with B.C. Hydro to discuss the agricultural implications of B.C. Hydro long range system plan.
>
> RECOMMENDATION 14 - The Guidelines for Linear Development on Agricultural Land should state that transmission line towers should avoid agricultural lands. An order of avoidance should be based on agricultural, economic, and social values, alternate areas to meet local agricultural product demand, and the level of impact. The following is an example of such a ranking. This ranking could change based on local factors.
>
> 1. prime agricultural land[1] already in intensive cultivation
> 2. prime agricultural land where intensive cultivation is likely
> 3. moderate agricultural land[2] where irrigation is or will become practical
> 4. moderate agricultural land where large equipment is or will be used in cultivation
> 5. all cultivated or potentially cultivated land.
>
> Where such avoidance is not practical, mitigation measures such as the following should be undertaken.
>
> 1. use of tower designs that minimize land loss
> 2. position towers along natural boundaries
> 3. positioning towers along farm and field boundaries
> 4. avoid multiple lines of towers by the use of multi-circuit towers
> 5. change the crops grown to those compatible with transmission lines.

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1. Prime agricultural land refers to land with an improved agricultural capability rating of class 3 or higher or that can grow important speciality crops.
2. moderate agricultural land refers to land with an improved agricultural rating of class 4 and 5.

The degree of mitigation should be determined by the degree of probable impact over the life of the transmission line. For example: With the exception of small distribution lines crossing irrigated or intensively cultivated land, the use of underground cables is probably impractical with present technology.

Weed Control

An increase in weeds around tower bases was evident in hay fields in Case Study 1 and in many of the published reports. In corn fields weeds under and around towers were sprayed. Weed control around tower bases represents a continual impact for cultivated areas, either in the way of lost yields or increased operating costs, or both. The major mitigation measures for weeds spreading around towers are the same as land loss around towers. Recommendation 14 is important for weed control as well as land loss. In addition to this the following is recommended.

> RECOMMENDATION 15 - A research project is needed to determine the most efficient means of weed control around transmission towers for different crops. Once this is complete, the results should be made available to farmers along electrical transmission rights-of-way.

The use of matchstepping[1] of towers to reduce weed impact appears to be impractical. Compensation for weed control measures may be required.

The other weed control problem is a reported outbreak of weeds just after line construction in Case Study 2. Rapid revegetation with approved seed mixtures reduced this problem. In addition to this measure which is already in general practice, the following recommendation is made.

> RECOMMENDATION 16 - Annual followup inspections and selective spraying of weeds should be conducted for two to three years after transmission line construction.

Soil Compaction and Disruption

Soil compaction and disruption was noticed immediately around towers both in the case studies and in previous research. It is difficult to distinguish between compaction caused by original construction methods and that caused by farm vehicles driving around towers. Another source of compaction is soil disruption that takes place during land clearing operations. The following recommendations are aimed at reducing this problem.

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[1] Matchstepping is the practice of placing towers of adjacent transmission lines next to each other.

RECOMMENDATION 17 - Wherever possible, electrical transmission lines should avoid wet, fine textured soils which are susceptible to compaction. If this is not possible, construction should be conducted in summer months when soils are dry or in winter when soils are frozen. Consideration should be given to draining wet, fine textured soils.

RECOMMENDATION 18 - Environmental procedure manuals should include methods for reclamation of tower construction sites, particularly those involving large concrete foundations.

Time Loss

Time loss was found to be a significant impact, depending on the size of the farm machinery used, the size of the transmission tower base, and the number of field operations per year. Recommendation 11 would reduce the impact of time loss as well as reduce the impact of land loss.

Increased Costs Immediately Around Towers

Several costs including fertilizer and seed were found to increase around towers in cultivated areas. Excluding weed control and time loss costs, these expenses were found to be less than $10. per tower per year. Recommendation 14 would reduce these costs as well as reduce land loss.

Collisions of farm equipment with towers were found in both Case Study 1 and in the literature. The loss of a piece of equipment at a critical time can mean a large impact.

RECOMMENDATION 19 - The costs of farming around towers should be considered when developing compensation and considering mitigation measures on potentially cultivated land.

RECOMMENDATION 20 - Hard-to-see guy wires should be clearly marked to assist farmers in avoiding them.

Increased Access

In fenced and intensively cultivated areas, increased access was not observed to be a major problem. Maintenance crews were in general courteous and conscientious. Farm access was a problem in the Crown range area of Case Study 2; however it was hard to separate the increase in the problem caused by the transmission line over the endemic problem of recreational and industrial use of the range.

> RECOMMENDATION 21 - The Farmland Resources Branch, regional and district agricultural and range personnel should carefully review access plans for all new or modified electrical transmission lines. Such plans once approved should form part of the terms and conditions of approval.
>
> RECOMMENDATION 22 - Electrical utilities should be prepared to cooperate with coordinated resource management plans and projects in areas where they have existing or planned transmission lines.
>
> RECOMMENDATION 23 - The Guidelines for Linear Development on Agricultural Land should include provision for the installation of fences and cattle guards where needed to reduce impacts associated with non-authorized traffic along an electrical transmission right-of-way.

Irrigation

Electrical transmission line interference with automated irrigation equipment was found to be one of the most significant sources of increased agricultural cost. There are many mitigation techniques for reducing this problem.

> RECOMMENDATION 24 - The Guidelines for Linear Development on Agricultural Land should include a guideline similar to the following.
>
> Electrical transmission lines should avoid areas where automated irrigation systems are either in use or are likely to be used.
>
> Where this is not possible or practical, mitigation measures such as the following should be employed; the positioning of towers along natural farm or field boundaries and development of automatic irrigation systems that are compatible with transmission lines.

While the above recommendation would reduce the impact of future transmission lines, improvement could also be made to existing lines.

> RECOMMENDATION 25 - Where existing transmission lines are shown to interfere with automated irrigation systems, the electrical utility involved should help design a system that is compatible with the existing line. Compensation for the increased cost of any system should also be considered.

> RECOMMENDATION 26 - The Ministry of Agriculture and Food, Engineering Branch, and/or B.C. Hydro should be encouraged to prepare a bulletin on the design and operation of irrigation equipment around and under electrical transmission lines.

Electrical and Electro-magnetic Effects

Three perceived electrical effects of high voltage transmission were noted in the case studies and in the literature. The first was a general concern for farming in the electric fields of transmission lines. The preponderance of papers reviewed in the annotated bibliography indicated that the threshold of such effects is several times stronger than the maximum field strength under transmission lines. The second area of concern was transect shock which may be received by farmers working with machinery under transmission lines. These shocks are a nuisance but not directly harmful. The third concern was the contribution transmission lines made to "electrical pollution" and tingle voltages. The following recomendations are aimed at not only reducing these problems but also reducing the anxiety that surrounds them.

> RECOMMENDATION 27 - Electrical utilities should supply farmers with more detailed information about working under power lines. This should include types such as avoiding shocks when operating farm machinery and handling electric fences under lines.

> RECOMMENDATION 28 - The B.C. Utilities Commission or similar independent body should commission a review of B.C. Hydro reports on audible noise, radio interference and field strength, and issue a public statement on the results.

RECOMMENDATION 29 - More information and research on tingle voltages is needed. Research should include national and international support as problems with tingle voltages occur internationally.

Compensation

Several problems of the current system of compensation were found during the case studies. The most basic of these was the farmer's lack of knowledge concerning the potential impacts of the project or their rights in negotiating compensation. The Hydro and Power Authority Act includes in the definition of owner or "lessee in possession for a term of three years of less". Two farmers who rented at the time compensation was given said they did not receive compensation. Another problem is that farming technology changes rapidly and a one-time compensation may not reflect the value of future impacts. The following recommendations address these concerns.

RECOMMENDATION 30 - Owners and tenants along proposed power transmission lines should be contacted and informed of their rights and potential impacts of the project.

RECOMMENDATION 31 - The protection given owners in Section 74 of the National Energy Board Act (C60, 1981), should be extended to projects reviewed under the Provincial Energy Project Review Process. Key protections include the right to annual compensation with a review every five years.

RECOMMENDATION 32 - Compensation should be given for land fractioning caused by two or more projects that are close but not adjacent.

RECOMMENDATION 33 - Compensation in kind, such as improvements to land to replace land lost to transmission towers should be considered.

Cattle Grazing

Increases in the capacity of land to support grazing animals were found to be the largest positive impact of transmission lines. In areas of Crown Range which were previously covered by coniferous forest, transmission line rights-of-way saved ranchers $1000./ha in clearing and seeding costs and added 0.8 animal units per year per hectare of cleared right-of-way. A high level of range management was needed to realize the benefits of land clearing along transmission line rights-of-way. Without careful management, cattle may over-concentrate on the right-of-way and not make the most efficient use of the entire range resource.

> RECOMMENDATION 34 - The Ministry of Agriculture and Food should provide ranchers with training on the management of Crown Range crossed by major transmission lines.

4.3 Pipeline Transmission

4.3.1 Current Regulation

While few existing or proposed electrical transmission lines are regulated by the National Energy Board (NEB), most of the existing and proposed pipelines in B.C. are actively regulated by the NEB. The NEB Act regulates all pipelines connecting a province with any other and includes all branches and auxiliary facilities. Under this definition the NEB Pipelines Branch regulates the Trans Mountain Pipe Line system, the Westcoast Gas Pipeline system including gathering lines, and the Alberta Natural Gas Company pipeline in the Kootenays. The only pipelines not regulated are the distribution systems operated by B.C. Hydro and Inland Natural Gas Company Ltd.

The B.C. Utilities Commission Act creates an overlapping jurisdiction between the Federal and Provincial governments. The proposed natural gas pipeline to Prince Rupert to supply Dome Petroleum's liquified natural gas (LNG) plant could come under both Federal and Provincial regulation. It is unlikely that the federal government would grant the power to expropriate provincially-owned Crown land as long as the national interest was not at stake. Another jurisdictional dispute is possible with the transmission of gas to Vancouver Island. If Westcoast Transmission undertakes the job it will be regulated by NEB; if B.C. Hydro supplies the gas it probably will not be regulated by the NEB. Both the NEB Act and B.C. Utilities Commission Act contain procedures for choosing between competing energy proposals. Neither Act provides for joint hearings or procedures with the other body.

The following is a summary of the current regulatory structure of the NEB for pipelines. The Utilities Commission Act provides for pipeline regulations that are identical to those for electric transmission lines (outlined in Section 4.2.1). General recommendations are made in a subsequent section for the NEB regulated case, the provincially regulated case, and the dual regulated case. The specific impact management recommendations made in Section 4.3.3 are independent of which regulatory bodies are present.

Federal Regulation

The National Energy Board Act (C-46, 1959) established the NEB as the basic federal agency responsible for protecting national interests with regard to energy supply, including safety and environmental protection. An amendment was passed this year that detailed a procedure for regulating pipelines under the NEB jurisdiction.

Any proposed project or minor extension of a regulated system is discussed informally until a formal application is made. During formal discussion agriculture and environmental concerns are normally handled by NEB staff without referral to other federal or provincial agencies. Part IV of the National Energy Board Rules of Practice and Procedure include a detailed description of environmental information required to be filed by the applicant including the following:

- An evaluation of environmental factors with respect to alternate routes considered and the reasons for selecting the proposed route.
- A proposed description.
- A description of the project area including CLI information and description of current and proposed land use in agricultural areas.
- A description of the natural environment including a mapped and narrative description of soil types and capability classes of agricultural lands.
- A qualitative and, where feasible, quantitative assessment of the probable impact on the environment or land and resource uses including agriculture.
- A description of mitigation plans including topsoil preservation and compatibility with agriculture.
- An assessment of the residual impacts.

Once a formal application is submitted, all communications from the NEB to the proponent are made through its lawyer. The environmental information included with the application is received by the NEB environmental staff and a formal deficiency letter is sent to the proponent if any omissions are found. The NEB then sets the date of the first of two hearings. NEB hearings are held as formal Courts of Inquiry. Any member of the public or group can intervene in these proceedings. The NEB then meets and reaches a decision and a public document is released giving the reasons for the discussion. If approved, the project is issued a Certificate of Public Convenience which can be subject to any terms and conditions set by the NEB.

Up to this point the NEB procedure is fairly similar to the B.C. Utilities Commission. One major difference is the protection of land owners. The NEB Act includes several protections for the land owner not found in the B.C. legislation. Section 74 of the NEB Act, includes regulations controlling the acquisition of land for a pipeline. These are given below:

Section 74, subsection 2 of the NEB Act includes the requirement:

(2) A company may not acquire lands for a pipeline under a land acquisition agreement unless the agreement includes provision for:

> (a) compensation for the acquisition of lands to be made, at the option of the owner of the lands, by one lump sum payment or by annual or periodic payments of equal or different amounts over a period of time;
>
> (b) review every five years of the amount of any compensation payable in respect of which annual or other periodic payments have been selected;
>
> (c) compensation for all damages suffered as a result of the operations of the company;

> (d) indemnification from all liabilities, damages, claims, suits and actions arising out of the operation of the company other than liabilities, damages, claims, suits and actions resulting from gross negligence or wilful misconduct of the owner of the lands;
>
> (e) restricting the use of the lands to the line of pipe or other facility for which the lands are, by the agreement, specified to be required unless the owner of the lands consents to any proposed additional use at the time of the proposed additional use; and
>
> (f) such additional matters as are, at the time the agreement is entered into, required to be included in a land acquisition agreement by any regulations made under paragraph 75.29(a).

Owners considered in this section include all persons having an interest which could be damaged by the pipeline (Section 64). Section 75 details the method of notice to land owners along a proposed line and a procedure for arbitration where negotiation has not produced a settlement. Once landowners have been identified, the NEB holds a second hearing. This is a land owner hearing where details of the right-of-way alignment and site specific mitigation measures are discussed. Changes in route and additional terms and conditions can be made based on these hearings. A detailed line list is made in the form of an air photo mosaic. This line list is similar to the Environmental index maps used by the B.C. Utilities Commission Steering Committee for the Kelly Lake to Nicola electrial transmission line. It includes all complaints, problems with drainage, fence lines and access routes.

In general, the above system of regulation and enforcement has never been used in B.C. Many of the requirements have only been incorporated as law since 1980. So, to some extent the NEB is as new a system as the

Utilities Commission. Another major problem is the fact that the NEB works out of Ottawa. None of the farmers interviewed along the Westcoast Pipeline knew what the NEB was or how it was intended to protect their rights. Since the NEB has no B.C. staff and no one makes inspections after completion of a project it relies on owner complaints for most of its ongoing enforcement. Problems similar to those found along the pipeline in Case Study 1 have been addressed by the NEB in Ontario for years. NEB pipeline environmental staff did not know that similar problems exist in B.C., that a provincial Agricultural Land Reserve or a Provincial Utilities Commission Act exists.

One of the documents reviewed by this study was a Landowner's Handbook for the proposed North Bay Shortcut Pipeline proposed for Northern Ontario. This booklet is informative but carefully avoids any mention of an owner's right to annual or periodic payments, with a review every five years of the payment amount. It did make clear that compensation would be paid for continuing loss of yields in addition to the original payment. Farmers in B.C. are relatively unaware of either of these provisions of the NEB Act.

Provincial Regulation

In theory Provincial regulation of pipelines is the same as a provincial regulation of electrical transmission. Pipelines capable of transporting 16 PJ of energy per year (equivalent to 2,570,000 barrels of crude oil) are regulated projects under the Utilities Commission Act. Smaller pipelines can be regulated under the Guidelines for Linear Developments if so directed by Cabinet. In practice, most small pipelines are handled by inter-agency referral at the local level. Regulated pipeline projects would follow the same procedures as electrical transmission lines (Section 4.2.1). The Agricultural Land Commission reviews all new pipeline routes that cross the Agricultural Land Reserve in the same manner as electrical transmission lines. (Section 4.2.1)

4.3.2 Conclusions and General Recommedations

The literature search yielded fewer scientific studies on the impacts of pipelines on agriculture than for the impacts of electrical transmission lines. There was a deficiency of data on the possibility for continuing yield loss on different soils after pipeline construction. There is also little information on the success of mitigation measures such as subsurface drainage (see Recommendations for Further Study, Section 3.4).

Based on Case Study 1 and the literature review, pipelines were found to present fewer risks and opportunities to agriculture than electrical transmission lines. Compressor and similar stations represented the only significant land losses. This land loss is estimated at less than 200 ha in the Agricultural Land Reserve. Construction phase impacts of pipelines are well documented and compensation measures appear adequate. The only major effect pipeline right-of-ways have on farming operations is through the restriction on buiding development on the right-of-way. For this reason, new pipeline rights-of-way should avoid existing agricultural communities. The most significant impact on agriculture for pipelines observed was the continuing loss of yields immediately over trenches. This problem probably only occurs in fine textured soils or where contractors did not follow approved procedures.

Both the federal and provincial regulatory systems are able to provide for adequate pipeline impact management for agriculture. The federal system gives a higher level of protection to land owners but suffers from a serious lack of communication and unfamiliarity with resource issues in B.C. The provincial system has a high degree of input from local agricultural field staff, Regional Resource Management committees, and landowners. To some extent the level of protection provincially is provided by terms and conditions on given projects rather than through legislation. A weakness of both systems is that the impacts from small projects such as petroleum exploration and extraction are not always considered.

The following general recommendations are aimed at improving pipeline/agriculture interactions:

> RECOMMENDATION 35 - A clear delineation should be made between federal and provincial jurisdictions over pipelines. Where pipelines have both national and provincial significance a joint process should be developed.
>
> RECOMMENDATION 36 - The strengths of both the provincial and federal regulatory systems should be adopted by all agencies involved with environmental review. Specifically, stronger protection for owners should be adopted by the B.C. Utilities Commission and the federal NEB should utilize the expertise of provincial field staff for assessing agricultural and range concerns.
>
> RECOMMENDATION 37 - All owners, tenants and others with interests along existing and proposed pipelines should be informed of their rights and which agencies are responsible for enforcing those rights. The right of owners to annual compensation under the NEB and broad definition of 'owner' should be publicized.
>
> RECOMMENDATION 38 - Problems with poor drainage and possible continuing yield loss along pipeline routes through fine textured soils should be researched, possibly by a project funded jointly by pipeline operators and government.
>
> RECOMMENDATION 39 - The NEB should be made aware of the Guidelines for Linear Development on Agricultural Land and the use of these guidelines in regulating impact management.

4.3.3 Impact Management Recommendations

Building Development

Normally, pipeline easements forbid building development on the right-of-way. In intensively farmed areas this can prevent needed expansion of farm buildings. The Guidelines for Linear Development on Agricultural Land encourages the placement of linear projects outside the Agricultural Land Reserve and along roads and property lines. Much of the land in the ALR is not being intensively farmed now and will not be in the forseeable future. Pipelines are the least impacting on agriculture of any linear development. Pipelines could be considered as compatible with the ALR as long as the area is not expected to be used for building-oriented agriculture such as dairy, poultry, or food processing. Building-oriented agriculture can develop land of low agricultural capability near cities. Where possible, these areas should be avoided by pipelines.

> RECOMMENDATION 40 - Pipelines should avoid areas of existing or expected intensive agricultural development. Where this is not possible, pipelines should be routed adjacent to other linear developments (common corridors) or along property lines.

Land Loss

The only sources of land loss along pipelines are stations, such as compressor stations on gas pipelines and pumping stations on oil pipelines. The above-ground portions of these stations often occupy 10 ha. Land required for below-ground facilities, room for expansion and a sound buffer area often cause a pipeline operator to use over 20 ha per station. Metering stations occupy less than 1 ha; catalytic inspection posts are small and are normally placed on fence lines.

> RECOMMENDATION 41 - Compressor and pumping station should be constructed on land with the least agricultural capability and suitability possible.

> RECOMMENDATION 43 - Where land is required around stations in agricultural areas for future growth, noise buffers or underground facilities, the use of easements rather than outright ownership by the utility should be considered.

Loss of Yield

Continuing loss of yields on fine textured soils is potentially the greatest impact of pipelines on agriculture.

> RECOMMENDATION 44 - Further research on loss of yield is needed before farm policies can be developed. Under the NEB Act any such losses would require remedial action and/or compensation by the pipeline operator.

It should be noted that the current environmental procedure manuals used by Westcoast Transmission and the Guidelines for Linear Development on Agricultural Land include detailed provision for the preservation of topsoil along pipelines.

Increased Access

Increased access may cause a variety of impacts along pipelines. In general, these impacts will only occur in remote areas where fields are normally not fenced and wilderness recreational use is allowed. No problems were noted with increased access in Case Study 1. Potential problems include compaction of range soils from snowmobiles and all terrain vehicles, weed spread and vandalism. Pipeline companies are aware of the problems and assist by placing advertisements in local newspapers and fencing where necessary. Problems of non-farm access are endemic to some areas; a pipeline could concentrate existing problems (see Section 4.2.3, Increased Access).

The following recommendations are aimed at improving the relationship between agricultural and recreational users of pipelines.

> RECOMMENDATION 44 - The Farmland Resources Branch, NEB, and the regional and district agriculture and range personnel should carefully review access plans for all new pipelines and modifications to existing pipelines. Access plans once approved should form part of the terms and conditions if approved.
>
> RECOMMENDATION 45 - Pipeline operators should be prepared to cooperate with coordinated resource management plans and projects in areas where they have existing or planned pipelines.
>
> RECOMMENDATION 46 - The Guidelines for Linear Development on Agricultural Land should include provisions for the installation of fences and cattle guards where these are needed to reduce the negative impacts associated with increased non-authorized traffic along pipelines.

Drainage

The need to carefully realign and repair drainage ditches after installation of a pipeline is understood by every pipeline company and regulatory agency contacted. What is not clearly understood is that the presence of a pipeline may alter the drainage pattern substantially. Water may travel along a pipeline thereby increasing yields and trafficability in high areas and adding water to low areas where there may be already an excess of water. In dry summers the impact of this change in drainage pattern may be reversed with the water collecting in low areas having a beneficial effect. The observation of a variety of changes in yield and timing of crops along a pipeline may be due to changes in drainage pattern.

In addition to the preservation of existing drain lines and additional research already recommended, further efforts may be needed to manage possible changes in drainage patterns caused by pipelines.

> RECOMMENDATION 47 - Fine textured agricultural soils should be avoided by pipelines wherever possible as these soils are subject to compaction and changes in drainage patterns.
>
> RECOMMENDATION 48 - Terms and Conditions for either provincial or federal Certificates for Public Convenience and Necessity or similar document should include provision for remedial measures or compensation where changes in drainage pattern reduce harvestable yield. Some inspection procedure such as yield testing may be needed. Remedial measures could include installation of drainage/sub-irrigatin system such measures would be site specific.

Opportunities and Risks Associated with Pipelines on Crown Range Land

Several opportunities and risks were associated with the crossing of Crown range of electric transmission lines in Case Study 2. The most important of these was the increase in grazing capacities due to clearing of the right-of-way and planting of palatable grasses and legumes. Negative aspects include a need for increased range management, weed spread, and soil compaction. All of these aspects may also apply to pipelines. Both the positive and negative aspects will be less for pipelines because they have smaller rights-of-way and are seldom kept clear by chemical or mechanical means.

> RECOMMENDATION 49 - A case study should be conducted of an existing pipeline crossing of Crown range. If possible, this case study should be multidisciplinary.

4.4 Highways

4.4.1 Current Regulations

Normally, the British Columbia Ministry of Transportation and Highways is the developer of new highways in B.C. There are several exceptions to this. Private industrial roads (especially forest and mining roads) have been upgraded into provincial highway status with only minor route modifications. In some cases a road is developed by more than one interest. A road into a new mining area such as Tumbler Ridge or terminal facility such as the Port Simpson LNG terminal may function as both an industrial road and public highway.

The decision-making for such projects may involve both government and industrial parties. The federal government may be involved in the construction and planning of the Trans-Canada Highway System. The following is an Abstract from Environmental Assessment Procedures on Highway Projects in British Columbia, The Coquihalla Highway Project (M.J. Kent, 1982). This describes the review procedures where the Ministry of Highways is the proponent.

> "The British Columbia Government Ministry of Transportation and Highways addresses environmental concerns through two systems. This paper describes the most commonly used Referral Process where environmental agencies are contacted during the functional planning and design stage of highway projects. The other system is the Guidelines for Linear Development. Although no highway project has yet been designated under this process, the procedure and goals have been adopted on a number of projects in the corridor planning phase of some highway projects. The most successful system of addressing and mitigating environmental concerns in the multidisciplinary field is to combine both systems where possible. The paper describes the Hope-Merritt (Coquihalla) Project where the stage process and liaison in the referral method has evolved to ensure adverse environmental problems are avoided and, where potential impacts occur, mitigation and enhancement strategies are adopted in the design. The use of an on-site Environmental Officer during construction ensures that environmental practices are followed and resources protected."

Several other regulatory options are open in cases where other proponents are involved. If the Federal government is a major partner in a highway project, the Federal Environmental Assessment and Review Process would probably be instituted in addition to other review processes. This process is described in Section 4.5.1. If the road is part of an energy project, the impacts of associated roads may be considered by the B.C. Utilities Commission and the NEB or both. Roads associated with the development of mines would come under review of the Highway (Industrial) Act administered by the B.C. Ministry of Transportation and Highways, and the Mining Regulation Act. Roads associated with forestry development would come under the review of the Highway (Industrial) Act and the Forest Act. While the Highways Act, Highways (Industrial) Act, the Mining Regulation Act and Forest Act apply to roads, there is no direct mention of review of agricultural or environmental impacts in these Acts.

Local roads are normally planned by municipal governments or Regional Districts. Regional Resource Management Committees may be involved in the review of longer local roads.

The following is a review of both the referral system and the Guidelines for Linear Development as they relate to highway planning by the B.C. Ministry of Transportation and Highways.

Referral Process

The formal referral system is the normal procedure for envronmental review of highways in B.C. Under this process regional staff of the Ministry of Transportation and Highways submit a planning and conceptual design of a new highway to 13 agencies listed in Table 4-3. The Ministry of Agriculture and Food is not on the referral list but the Agricultural Land Commission is.

Normally this report indicates alternative routes. The agencies contacted are asked for major constraints and to indicate a preferred route. Where no alternatives are indicated, contacted agencies are asked for specific mitigative measures or alignment shifts to ensure the acceptibility of the project. The referral system has developed from a very centralized process to one that is now used predominantly by the six regional offices of the Ministry of Transportation and Highways. If a highway project is handled out of a regional office, regional resource officers in affected ministries will be contacted. If a highway is handled out of the Victoria Transportation and Highways Office, the head office staff of the affected ministry will be contacted.

If one or more of the agencies are unable to accept the proposed route, detailed impact assessment studies are carried out. Such a study would follow the process of the Guidelines for Linear Development.

Guidelines for Linear Development

The Guidelines for Linear Development (Environment and Land Use Committee, 1977) are the same as those discussed for moderately-sized transmission projects in Section 4.2.1. These Guidelines are only applicable if the Environment and Land Use Committee of cabinet so designate for a particular project. No highway project to date has been so formally designated. The Guidelines lay out a multi-stage process:

> A prospectus (general introduction to the project and its economic benefits and rationale for inception); a Stage I overview on environmental concerns for alternative corridors; a Stage II detailed inventory and mitigation document leading to route selection; Stage III, permitting and Stage IV, project implementation.

Although no project has yet followed these Guidelines, the Ministry of Transportation and Highways has adopted a modified version of the Guidelines for internal use. Based on experience during the Coquihalla Project, the following modification to the Guidelines are anticipated by the Ministry of Transportation and Highways. A Stage I overview study would be prepared for most projects. This would be followed by a second stage investigation which would include site specific studies, consultation with government agencies and interested groups, and development of mitigation measures. The measures developed in the Stage II studies would be incorporated into the project's design and implemented in the field and checked by a Construction Environmental Officer.

If a highway is to be constructed through the Agricultural Land Reserve, plans are submitted by the Agricultural Land Commission as a special use under Section 44 of the Agricultural Land Reserve Procedure Regulation (B.C. Reg. 313/78). This is the same procedure as the one followed for development of electrical transmission lines and pipelines. (Section 4.2.1)

4.4.2 Conclusions and General Recommendations

Roads and highways have the greatest impact on agriculture of all known projects reviewed. These impacts include large areas of land lost and additional losses due to land fractionation. Roads and highways are necessary for agricultural development. In practice, the existing review processes are equivalent to self-regulation by a linear developer as they do not involve basic approval by any third party or Certificate of Public Convenience by an independent authority. The following recommendations are aimed at improving the interaction between highway development and agriculture.

> RECOMMENDATION 50 - The B.C. Ministry of Agriculture and Food, Farmland Resources Branch, should be added to the Ministry of Transport and Highways interagency contact list. The Farmland Resources Branch would then contact the agricultural and range staff appropriate for any proposed highway.
>
> RECOMMENDATION 51 - The Agricultural Land Commission offers a good mechanism for controlling the alienation of farmland within the ALR but not of areas outside the ALR. The present regulatory structure does not include a clear mechanism for comparing the loss of agricultural land to the loss of forestry and wildlife values. This multidisciplinary weighting of impacts on alternative routes is a key to both provincial and Federal regulation of energy projects and should be applied to highways.
>
> RECOMMENDATION 52 - The highways review process does not have a normal procedure for a land owner to request a minor route realignment. Such a procedure could lessen the amount of land loss caused by a road.
>
> RECOMMENDATION 53 - Industrial roads can have all the negative and positive impacts of Provincial highways. Environmental and agricultural review processes developed for highways should be considered for industrial roads.

RECOMMENDATION 54 - The Ministry of Transportation and Highways should prepare an Environmental Procedures manual similar to that used by other linear developers. This manual should include measures for the avoidance and mitigation of agricultural impacts.

RECOMMENDATION 55 - The Guidelines for Linear Development on Agricultural Land should include a section on highways.

4.4.3 Impact Management Recommendations

Land Fractionation

Highways are basically an exclusive use of land. They also have severe restrictions in their requirements for relatively flat grades. For this reason, highways have tended to be constructed over flat farmland. Originally, roads were used by both local and through traffic. Limited access highways are used for long range travel. This separation has led to a greater need for mitigation planning so that through-highways do not interfere with farm traffic or isolate areas of farmland too small to be farmed efficiently.

RECOMMENDATION 56 - The planning documents for all new highways or upgrading of existing roads to highway status should include maps showing where cultivated and potentially cultivated land would be crossed.

RECOMMENDATION 57 - Where farms are divided by a new highway, the farmer should be contacted and mitigation necessary such as minor route realignments or farm traffic culverts could be identified.

RECOMMENDATION 58 - Design guidelines for highways should be developed to include minimum sizes for irrigated and non-irrigated fields that can be farmed efficiently. Where these minimums are not practical mitigation and compensation should be considered.

Land Loss

Of all linear projects, highways and roads alienate the largest areas of agricultural land.

RECOMMENDATION 59 - The Agricultural Land Commission should investigate the methods used to evaluate alternative routes for new highways which cross the Agricultural Land Reserve. They should also review mitigation procedures for impacts such as the fractionation of farmland.

RECOMMENDATION 60 - The Farmland Resources Branch should inform the Ministry of Transportation and Highways when a proposed route crosses land with agricultural potential that is not in the Agricultural Land Reserve.

RECOMMENDATION 61 - The use of highway right-of-ways for agricultural production can lower the amount of land loss and should be considered.

RECOMMENDATION 62 - Where extensive land loss occurs due to highway construction, compensation in kind, such as the improvement of marginal agricultural land should be considered. This is especially true where a highway alienates a sufficient area of farmland to weaken the agricultural infrastructure.

RECOMMENDATION 63 - The use of narrow right-of-ways with easements for future expansion should be considered in agricultural areas.

Increased Access

No information was gathered on the effects of increasing access due to highways. On highly developed agricultural areas such as the Sumas Valley, additional highways would not increase problems with unauthorized use. In ranching areas such as Williams Lake, new highway development could lead to more recreational use of rangeland. Impacts from such access would be similar and perhaps greater than those caused by transmission lines.

RECOMMENDATION 64 - Regional Resource Management Committees and Coordinated Resource Management project committees should be kept informed and have input on any highway development project in their areas.

RECOMMENDATION 65 - Farmers and ranchers should be informed as far in advance of highway construction as possible. Mitigation measures such as realignment should also be considered during highway planning or after construction by an interdisciplinary team.

Irrigation and Drainage

Development of highways and industrial roads can block the flow of irrigation, drainage ditches and pipes. Culverts are used to carry any existing water in ditches or pipes under roadways. Once a highway is in, the farmer must pay for any ditch or pipe crossing. There has been debate as to where the road interferes with natural groundwater flow. Problems could arise if a road either inhibits excess water moving off poorly drained farmland, or limits the amount of water a dry field receives through natural subirrigation. Further research is needed to quantify this possible type of impact. See Section 3.4 Recommendations for Further Study, No. 4.

Large automatic irrigation systems, especially pivot systems, require large unbroken fields. A highway or road through such an area could greatly increase the cost of irrigation.

> RECOMMENDATION 66 - Highways and industrial roads should avoid locations where they will interfere with automated irrigation systems. Where this is not possible, compensation should be considered.

Cattle Grazing

No information was gathered on the effects of highway or industrial road construction on cattle management. Impacts could include both the opening of new range, land loss and interference with cattle movement. The noise levels along busy highways could also affect cattle movements. See Section 3.4 Recommendation for Further Study, No. 12. It is the policy of the Ministry of Transportation and Highways to construct and maintain fencing as needed by both ranchers and farmers on all public class highways and roads.

4.5 Railways

4.5.1 Current Regulations

Railways, especially those capable of handling resource unit trains are the most demanding linear development in terms of their physical requirements. Maximum grades in the past were 2.2%, but are now 1%. The maximum curve is 6°. They are also the most expensive linear development with costs of over a million dollars a kilometre on level ground. This cost rapidly increases over rougher terrain. There are three railways that come under the jurisdiction of the Canadian Transport Commission: CN, CP, and Burlington Northern. The B.C. Railway and the B.C. Hydro Railway come under the jurisdiction of the B.C. Ministry of Transportation and Highways. All railways operating in B.C. accept the principles of the Guidelines for Linear Development (ELUC, 1977), but only come directly under the Guidelines if so designated by the Provincial Cabinet.

There are several regulatory processes governing railway development. Small spur lines are dealt with on a permit basis. Permits are required under many acts for railway development. These include the Agricultural Land Commission Act, the Forest Act, Waste Management Act, Heritage Conservation Act, Highways Act, Land Act, Railway Act, Municipal Act, Soil Conservation Act, Water Act, etc. A railway developer may wish to use the Guidelines for Linear Development Act as a way of coordinating permit applications.

Larger Provincially regulated projects would probably be designated under the Guidelines for Linear Development if proposed by B.C. Railway. Major new development by CNR and CPR would be largely subject to federal jurisdiction and review processes. The Canadian Transport Commission is largely concerned with safety and railway operating procedures. The major federal environmental review process for new railways under federal jurisdiction is the Federal Environmental Assessment and Review Process. The following is a short summary of environmental review of two current railway projects in B.C.

The most recent new railway right-of-way in B.C. is the Anzac-Table-Wolverine-Quintette Railway which is now under construction in northeastern B.C. The environmental assessment and review of alternative routes was handled informally by B.C. Railway under the sponsorship of the Environment and Land Use Sub-Committee on Northeast Coal Development. Once the current route was chosen, a formal Stage II submission for the Anzac route was made pursuant to the Guidelines for Linear Development. Minor spur lines are reviewed under the Guidelines for Linear Development if constructed by B.C.R. and under the Guidelines for Coal Development if the design and construction of the spurs are considered to be a coal company's responsibility.

Since most new railway right-of-way will be associated with major resource extraction, the planning for the railway will probably, like the Anzac line, be reviewed by a special task force on the entire process. Agricultural concerns, both with the mining operation and associated linear developments, will have to be handled together on a project-by-project basis in such cases.

Most railway development in B.C. will be upgrading of existing rights-of-way, not the creation of new rights-of-way. A case in point is the double tracking of the CN railway from Valemont to Vancouver. Originally, it was thought that little review would be made. Concerns were raised by the B.C. Ministry of Environment about the potential impacts of construction on fisheries and other environmental resources. Environment Canada subsequently initiated the Federal Environment Assessment on Review Process. This Process and the Federal Environmental Assessment Review Office (FEARO), who administers it, was established by Cabinet on December 20, 1973. The Process aims to ensure that:

a) environmental effects are taken into account early in the planning of new federal projects, progress and activities,

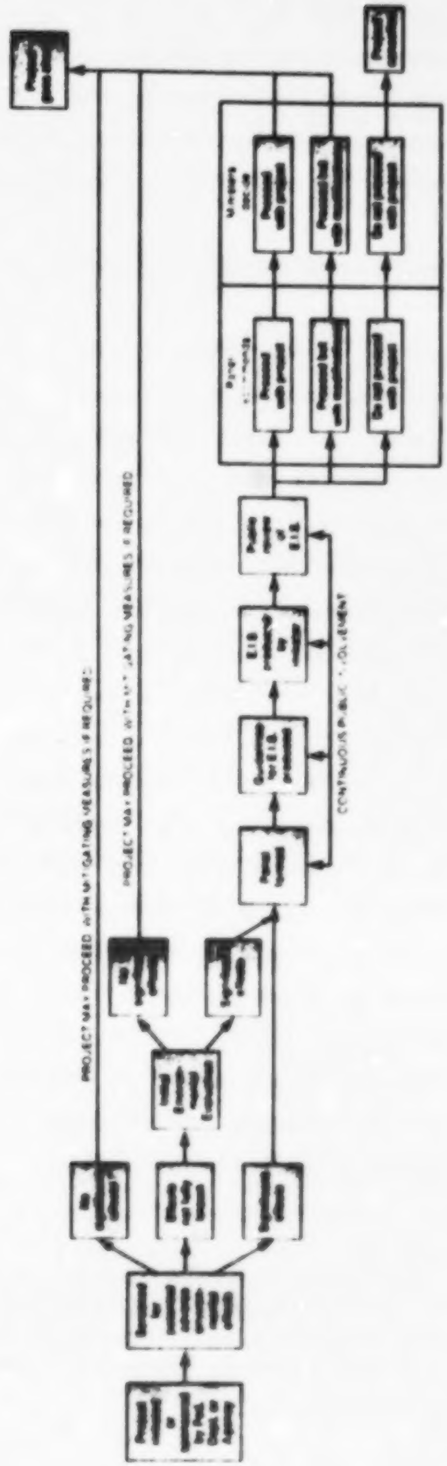
b) an environmental assessment is carried out for all projects that may have an adverse effect on the environment before commitments or irrevocable decisions are made,

c) the results of these assessments are used in planning, decision-making and implementation.

Federal projects are considered to be those that are initiated by federal departments or agencies, those for which federal funds are solicited and those involving federal property. Proprietary Crown Corporation (CNR) and regulatory agencies are invited, rather than directed, to participate in the process. Although this definition of federal projects appears to be quite limited, it probably could cover most major railway development by CNR and CPR as such projects would cross Indian Reserves (federal property) and often require federal funding.

The Federal Government Environmental Assessment and Review Process is shown graphically in Figure 4-2. The first step is environmental screening by the project initiator. The Guide to Environmental Screening by the Federal Environmental Assessment Review Office describes a standard screening process. All alternate land capabilities (presumably but not explicitly including agriculture) are lumped together and a significant/not significant/unknown significance decision is made. The next step, if effects are not fully known, is an Initial Environmental Evaluation, normally made by the proponent. These studies are conducted under the Guidelines for Preparatory Initial Environmental Evaluations by the Environmental Assessment Panel, 1976. Included in these guidelines are three categories of linear projects: oil pipelines, electrical power transmission lines, and highways and railways. The guidelines give a format for a report but do not address agriculture specifically. Normally, provincial agricultural field officers are not involved at this stage. If no significant effect is found which can not be adequately mitigated during the screening and initial studies, a project can proceed. If significant effects are found, a formal Environmental Impact Study EIS is requested from the initiator.

FIGURE 4-2 FEDERAL ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS


PROJECT MAY PROCEED WITH MITIGATING MEASURES IF REQUIRED
PROJECT MAY PROCEED WITH MITIGATING MEASURES IF REQUIRED
CONTINUOUS PUBLIC INVOLVEMENT

A project panel is then formed by F.E.A.R.O. which sets guidelines for the EIS. The EIS is produced by the proponent. A public hearing is then held. After review and recommendations by the project panel, the federal cabinet makes a decision on whether or not a project goes forward and what mitigation and monitoring measures are required.

4.5.2 Conclusions and General Recommendations

Railway projects requiring new rights-of-way are relatively infrequent compared to other linear developments. Normally such new rights-of-ways will be associated with a major industrial, forestry, or mining development. For such projects only minor route changes may be practical to lower agricultural impacts. Avoiding land fractionation is a major consideration here. A potentially greater source of agricultural impact may be associated with expansion of current rights-of-way both in terms of new track and new facilities such as rail yards. Such expansion of current rights-of-ways may not come under environmental regulating agencies or even be known to people in the agricultural community. Such projects may result in much more agricultural land loss and land fractionation than the development of new right-of-way in remote mining areas. A third source of concern deals with the continuing operation of railways. These concerns include problems such as weed control and vegetation management of the right-of-way, crossings for cattle and farm vehicles and the potential of chemical spills from damaged rail cars.

The following recommendations are aimed at improving agricultural input to decision-making on new railway development, expansion of current rights-of-ways and operation of current facilities.

> RECOMMENDATION 67 - The B.C. Ministry of Agriculture and Food, Farmland Resources Branch, should establish formal communications with the Canadian Transport Commission, B.C. Ministry of Transportation and Highways and Federal Environmental Assessment Review Office. These agencies should be informed of agricultural

concerns with the development, expansion and operation of railways. The Farmland Resources Branch could then contact the agricultural and range staff appropriate for a given railway project.

RECOMMENDATION 68 - Railway operators should be encouraged to prepare Environmental Procedures Manuals, including information on cattle and farm vehicle crossings, vegetation management, and contingency plans for chemical spills on agricultural land.

RECOMMENDATION 69 - The Guidelines for Linear Development on Agricultural Land should include a section on railways.

RECOMMENDATION 70 - A mechanism should be found for early agricultural input to the Federal Environmental Assessment and Review Process.

4.5.3 Impact Management

Railways are similar to roads in many aspects. They both are a single use roadbed with a need for level grades, shallow curves and connect intensively used centres. For this reason all of the recommendations in Section 4.4.3 Impact Management: Highways also apply to railways. It should be noted that as realignments of railways are often more costly than road realignments, more emphasis should be placed on mitigation and compensation for railways. Another difference is that, while highway rights-of-way are 'inspected' by thousands of people who travel them, railway rights-of-way do not receive such close scrutiny and may have less attention paid to weed control.

Note: All recommendations under Section 4.4.3 Impact Management on Highways apply to railways as well.

RECOMMENDATION 71 - A procedure and standards for weed control on railway rights-of-way should be worked out between railway operators and the Ministry of Agriculture and Food.

RECOMMENDATION 72 - A contingency plan should be prepared for potential chemical spills on agricultural land.

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MAPS NOT

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British Columbia

Ministry of
Agriculture and Food

Government
of Canada

Gouvernement
du Canada

Agriculture
Canada

OPPORTUNITIES AND RISKS PRESENTED TO AGRICULTURE BY LINEAR DEVELOPMENTS

PROJECT NO. 271315

UNDER

CANADA, BRITISH COLUMBIA SUBSIDIARY AGREEMENT ON

AGRICULTURE AND RURAL DEVELOPMENT

December, 1983

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Vancouver, B.C.

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Opportunities and Risks Presented to Agriculture by Linear Developments

Appendix 1

Existing and Proposed Linear Project List

Appendix 1 Existing and Proposed Linear Project List

Electrical

Appendix 1a B.C. Hydro Electrical Transmission

B.C. Hydro provided the following project lists. Projects of over 230 kV (existing, under construction or proposed) hae been included in the inventory map and Linear Projects Overview table. Details as to structure types and right-of-way width, are given in Table A-1.

TABLE A-1 B.C. HYDRO PROJECT LIST

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

TRANSMISSION LINE LENGTHS

AS AT 31 MARCH 1982

CIRCUIT VOLTAGE	TYPICAL BCH ROW WIDTHS (m)	POLES		STEEL TOWERS		TOTALS		UNDERGROUND LINES		SUBMARINE CABLES	
		POLE km	CIRCUIT km	TOWER km	CIRCUIT km	STRUCTURE km	CIRCUIT km	CIRCUIT km	CABLE km	CIRCUIT km	CABLE km
500 kV Circuits	64			4,497.04	4,497.04	4,497.04	4,497.04				
360 kV Circuits				329.69	329.69	329.69	329.69				
287 kV Circuits		103.45	103.45	83.83	83.83	187.28	187.28				
230 kV Circuits	42.7	1,549.42	1,551.77	970.03	1,080.83	2,519.45	2,632.60	92.01	276.05		
DC Circuits		46.02	67.74	54.63	109.58	100.65	177.32			163.91	163.91
132 kV Circuits	30.5	3,232.44	3,233.94	509.47	799.45	3,741.91	4,033.39	6.25	18.73	56.91	198.84
60 kV Circuits		3,492.80	3,540.61	67.64	119.33	3,560.44	3,659.94	45.10	143.53	0.27	0.81
46 kV Circuits		32.15	32.15			32.15	32.15				
34 kV Circuits		0.87	0.87			0.87	0.87				
	TOTAL	8,457.15	8,530.53	6,512.33	7,019.75	14,969.48	15,550.28	143.36	438.31	221.09	363.56
IN PLACE - OUT OF SERVICE											
60 kV Circuits		23.35	23.35			23.35	23.35				
34 kV Circuits		3.80	3.80			3.80	3.80				
	TOTAL	27.15	27.15			27.15	27.15				

STM2H

CIRCUIT NO.	CIRCUIT LOCATION	REFERENCE DRAWING	POLES		STEEL TOWERS		TOTALS		UNDERGROUND LINES		SUBMARINE CABLES	
			POLE km	CIRCUIT km	TOWER km	CIRCUIT km	STRUCTURE km	CIRCUIT km	CIRCUIT km	CABLE km	CIRCUIT km	CABLE km
500 kV LINES												
5 L 01	G. M. Shrum x Williston	T10-B22			277.29	277.29	277.29	277.29				
5 L 02	G. M. Shrum x Williston	T10-B15			277.29	277.29	277.29	277.29				
5 L 03	Peace Canyon GS to Williston	T10-B31			276.79	276.79	276.79	276.79				
5 L 04	Peace Canyon GS to G. M. Shrum	T10-B2			13.99	13.99	13.99	13.99				
5 L 11	Williston x Kelly Lake	T10-B18			329.43	329.43	329.43	329.43				
5 L 12	Williston x Kelly Lake	T10-B9			329.43	329.43	329.43	329.43				
5 L 41	Kelly Lake x Ingledow	T10-B10			319.13	319.13	319.13	319.13				
5 L 42	Kelly Lake x Meridian	T10-B30			257.03	257.03	257.03	257.03				
5 L 44	Meridian x Ingledow	T10-B1			19.57	19.57	19.57	19.57				
5 L 51	Ingledow x BPA				21.86	21.86	21.86	21.86				
5 L 52	Ingledow x BPA				21.86	21.86	21.86	21.86				
5 L 61	Williston x Glenannan				174.96	174.96	174.96	174.96				
5 L 62	Glenannan to Telkwa	T10-B4			131.48	131.48	131.48	131.48				
5 L 63	Telkwa to Skeena	T10-B23			142.91	142.91	142.91	142.91				
5 L 71	Mica x Nicola (Mica T/L #1)	T10-B48			285.13	285.13	285.13	285.13				
5 L 72	Mica x Nicola (Mica T/L #2)	T10-B39			285.13	285.13	285.13	285.13				

CIRCUIT NO.	CIRCUIT LOCATION	REFERENCE DRAWING	POLES POLE km	POLES CIRCUIT km	STEEL TOWERS TOWER km	STEEL TOWERS CIRCUIT km	TOTALS STRUCTURE km	TOTALS CIRCUIT km	UNDERGROUND LINES CIRCUIT km	UNDERGROUND LINES CABLE km	SUBMARINE CABLES CIRCUIT km	SUBMARINE CABLES CABLE km
500 kV LINES (cont'd)												
5 L 76	Nicola to Ashton Creek				117.32	117.32	117.32	117.32				
5 L 81	Nicola x Ingledow (Mica T/L #1)	T10-839			263.80	263.80	263.80	263.80				
5 L 82	Nicola & Meridian (Mica T/L #2)				248.44	248.44	248.44	248.44				
5 L 91	Selkirk to Ashton Creek				223.20	223.20	223.20	223.20				
5 L 92	Selkirk to Cranbrook				180.00	180.00	180.00	180.00				
5 L 98	Nicola to Selkirk				301.00	301.00	301.00	301.00				
	TOTALS				4,497.04	4,497.04	4,497.04	4,497.04				

STM2H

CIRCUIT NO.	CIRCUIT LOCATION	REFERENCE DRAWING	POLES POLE km	 CIRCUIT km	STEEL TOWERS TOWER km	 CIRCUIT km	TOTALS STRUCTURE km	 CIRCUIT km	UNDERGROUND LINES CIRCUIT km	 CABLE km	SUBMARINE CABLES CIRCUIT km	 CABLE km
360 kV LINES												
3 L 01	Atchelitz x Ingledow	36001-T10-B2			72.47	72.47	72.47	72.47				
3 L 02	BRT x Rosedale	M-51304 R-2			224.42	224.42	224.42	224.42				
3 L 03	Wahleach x Rosedale	M-73018			10.23	10.23	10.23	10.23				
3 L 04	Rosedale x Atchelitz	36004-T10-B1			19.09	19.09	19.09	19.09				
3 L 13	BRT x Bridge #2	M-41323			0.51	0.51	0.51	0.51				
3 L 14	BRT x Bridge #2	M-41324			0.47	0.47	0.47	0.47				
3 L 15	BRT x Bridge #1	M-41325			1.21	1.21	1.21	1.21				
3 L 16	BRT x Bridge #1	M-41326			1.29	1.29	1.29	1.29				
	TOTAL				329.69	329.69	329.69	329.69				

STRGM

CIRCUIT NO.	CIRCUIT LOCATION	REFERENCE DRAWING	POLES		STEEL TOWERS		TOTALS		UNDERGROUND LINES		SUBMARINE CABLES	
			POLE km	CIRCUIT km	TOWER km	CIRCUIT km	STRUCTURE km	CIRCUIT km	CIRCUIT km	CABLE km	CIRCUIT km	CABLE km
287 KV LINES												
2 L 99	Minette x Skeena	T10-820 R-1	58.85	58.85			58.85	58.85				
2 L 101	Skeena x Rupert	T10-81	42.09	42.09	83.83	83.83	125.92	125.92				
2 L 103	Kitimat x Minette	T10-81	2.51	2.51			2.51	2.51				
	TOTAL		103.45	103.45	83.83	83.83	187.28	187.28				

			POLES		STEEL TOWERS		TOTALS		UNDERGROUND LINES		SUBMARINE CABLES	
CIRCUIT NO.	CIRCUIT LOCATION	REFERENCE DRAWING	POLE km	CIRCUIT km	TOWER km	CIRCUIT km	STRUCTURE km	CIRCUIT km	CIRCUIT km	CABLE km	CIRCUIT km	CABLE km
230 kV LINES												
2 L 01	BRT x Cheekye	M-73829 R-1	2.35	2.35	135.43	135.43	137.78	137.78				
2 L 02	BRT x Cheekye	M-73803	1.59	1.59	136.42	136.42	138.01	138.01				
2 L 03	Walters x Horne Payne	M-57174			5.12	5.12	5.12	5.12				
2 L 04	Ingledow x Cambie Rd. Sub.	M-73821	15.61	15.61	0.98	0.98	16.59	16.59				
2 L 06	Ingledow x Arnott	2L6-T10-B9			16.85	16.85	16.85	16.85				
2 L 09	Cheekye x Lynn Valley	M-57173 R-1	3.87	3.87	56.38	56.38	60.25	60.25				
2 L 10	Ingledow x Arnott	M-56841	0.59	0.59	16.35	16.35	16.94	16.94				
2 L 11	Burrard x Walters	T10-B3			14.42	14.42	14.42	14.42				
2 L 12	Cheekye x Cheakamus	M-41303			19.96	19.96	19.96	19.96				
2 L 13	Cypress x Walters	M-57175	60.17	60.17			60.17	60.17				
2 L 14	Cypress x Walters	23014-T10-B1	16.20	16.20		6.53	16.20	22.73				
2 L 16	Cambie Rd. Sub. x Kidd #2		2.85	2.85	1.75	1.75	4.60	4.60				
2 L 17	Walters x Lynn Valley				3.88	3.88	3.88	3.88				
2 L 19	BRT x Bridge #1	M-41327	1.25	1.25	0.37	0.37	1.62	1.62				
2 L 22	Meridian x Port Mann	M-51651 O/H	16.51	16.51	3.51	3.51	20.02	20.02				
2 L 27	Whalley x Ingledow	M-51650	4.99	4.99			4.99	4.99				

[illegible]

CIRCUIT NO.	CIRCUIT LOCATION	REFERENCE DRAWING	POLES POLE km	POLES CIRCUIT km	STEEL TOWERS TOWER km	STEEL TOWERS CIRCUIT km	TOTALS STRUCTURE km	TOTALS CIRCUIT km	UNDERGROUND LINES CIRCUIT km	UNDERGROUND LINES CABLE km	SUBMARINE CABLES CIRCUIT km	SUBMARINE CABLES CABLE km
230 kV LINES (cont'd)												
2 L 39	Como Lake x Howell		6.36	6.36	6.60	6.60	12.96	12.96	3.33	9.99		
2 L 40	Howell x Burrard	M-58241 U/G M-73805 O/H			9.01	9.01	9.01	9.01	3.35	10.04		
2 L 43	Port Mann x Whalley		3.22	3.22			3.22	3.22				
2 L 45	Camosun x Sperling								6.08	18.25		
2 L 46	Howell x Mainwaring								9.50	28.50		
2 L 49	Murrin x Meridian		7.89	7.89		19.54	7.89	27.43	7.50	22.50		
2 L 50	Burrard x Murrin	M-58395	6.28	6.28	1.77	10.78	8.05	17.06	7.23	21.68		
2 L 51	Meridian x Horne Payne					11.26		11.26	16.87	50.60		
2 L 52	Meridian x Como Lake				6.28	6.28	6.28	6.28				
2 L 53	Murrin #2 x Mainwaring	M-58326							7.29	21.87		
2 L 54	Burrard x Meridian		0.32	0.32	7.40	7.40	7.72	7.72				
2 L 56	Ingledow x Camosun	T10-88	9.22	9.22	12.43	12.43	21.65	21.65	13.14	39.44		
2 L 57	Ingledow x Arnott (Towers on 2L10)		0.08	0.50		16.45	0.08	16.95				

STNDN

CIRCUIT NO.	CIRCUIT LOCATION	REFERENCE DRAWING	POLES POLE km	POLES CIRCUIT km	STEEL TOWERS TOWER km	STEEL TOWERS CIRCUIT km	TOTALS STRUCTURE km	TOTALS CIRCUIT km	UNDERGROUND LINES CIRCUIT km	UNDERGROUND LINES CABLE km	SUBMARINE CABLES CIRCUIT km	SUBMARINE CABLES CABLE km
230 kV LINES (cont'd)												
2 L 60	Kidd #2 x Steveston	23058-T10-B10			14.90	16.67	14.90	16.67				
2 L 61	Burrard x Meridian			0.32		7.40		7.72				
2 L 62	Arnott x Steveston				4.52	11.76	4.52	11.76	0.79	2.37		
2 L 63	Ingledow to Arnott (Towers on 2L6)		0.05	0.05		16.85	0.05	16.90				
2 L 64	Sperling to Kidd #2		0.51	0.51	0.48	0.48	0.99	0.99	7.00	21.00		
2 L 86	Kelly Lake x 100 Mile House	23086-T10-B7	82.37	82.37	2.01	2.01	84.38	84.38				
2 L 90	BRT x Kelly Lake	N-73856	74.00	74.00	2.35	2.35	76.35	76.35				
2 L 91	BRT x Kelly Lake		74.14	74.14	1.30	1.30	75.44	75.44				
2 L 92	Kelly Lake x Savona	N-73881	87.44	87.44		2.01	87.44	89.45				
2 L 93	Kelly Lake x Savona	T10-B6	90.82	90.82			90.82	90.82				
2 L 94	Kelly Lake x Soda Creek	N-73859	151.26	151.26	0.87	0.87	152.13	152.13				
2 L 95	Soda Creek x Red Bluff	N-73858	81.77	81.77			81.77	81.77				
2 L 96	Barlow x Williston	N-73858	94.76	94.76			94.76	94.76				
2 L 97	Williston x Salmon Valley	T10-B3	33.15	33.15			33.15	33.15				

OTHER

CIRCUIT NO.	CIRCUIT LOCATION	REFERENCE DRAWING	POLES POLE km	POLES CIRCUIT km	STEEL TOWERS TOWER km	STEEL TOWERS CIRCUIT km	TOTALS STRUCTURE km	TOTALS CIRCUIT km	UNDERGROUND LINES CIRCUIT km	UNDERGROUND LINES CABLE km	SUBMARINE CABLES CIRCUIT km	SUBMARINE CABLES CABLE km
230 KV LINES (cont'd)												
2 L 112	Boundary x Nelway	T10-811	0.87	0.87			0.87	0.87				
2 L 113	Cranbrook x Natal #2 (Aluminum Towers)	T10-88	5.17	5.17	71.95	71.95	77.12	77.12				
2 L 123	VIT to Sahtlam x Dunsmuir		2.10	2.10	103.90	103.90	106.00	106.00				
2 L 143	Horsey to Esquimalt								2.71	8.13		
2 L 176	VIT to Sahtlam to Horsey			1.61	59.50	66.40	59.50	68.01	7.22	21.68		
2 L 221	Seven Mile to Selkirk				4.02	4.02	4.02	4.02				
2 L 222	Seven Mile to Selkirk					4.02		4.02				
2 L 240	Ashton Creek x Salmon Arm		18.00	18.00	18.70	18.70	36.70	36.70				
2 L 253	Ashton Creek x Illecillewaet		3.14	3.14	74.71	74.71	77.85	77.85				
2 L 256	Ashton Creek x Vernon Terminal		48.12	48.12	1.45	1.45	49.57	49.57				
2 L 296	Ashton Creek x Vernon Terminal		48.12	48.12		1.45	48.12	49.57				
2 L 280	Cranbrook to Invermere		131.46	131.46			131.46	131.46				
2 L 288	Nicola to Valleyview		61.00	61.00	2.20	2.20	63.20	63.20				
2 L 293	Selkirk to Nelway		16.80	16.80	0.37	0.37	17.17	17.17				
2 L 294	Nelway x Cranbrook (Aluminum Towers)		10.25	10.25	151.52	151.52	161.77	161.77				

STRDN

CIRCUIT NO.	CIRCUIT LOCATION	REFERENCE DRAWING	POLES POLE km	POLES CIRCUIT km	STEEL TOWERS TOWER km	STEEL TOWERS CIRCUIT km	TOTALS STRUCTURE km	TOTALS CIRCUIT km	UNDERGROUND LINES CIRCUIT km	UNDERGROUND LINES CABLE km	SUBMARINE CABLES CIRCUIT km	SUBMARINE CABLES CABLE km
230 kV LINES (cont'd)												
2 L 295	Kootenay x Selkirk		44.39	44.39	0.37	0.37	'44.76	44.76				
2 L 299	Kootenay to Selkirk		45.00	45.00		0.37	45.00	45.37				
2 L 307	Barlow to Quesnel River Pulp		5.50	5.50			5.50	5.50				
2 L 352	100 Mile House to Soda Creek		103.18	103.18			103.18	103.18				
2 L 353	Glenannan to Tachick		63.49	63.49			63.49	63.49				
2 L 354	Barlow to Red Bluff		13.21	13.21			13.21	13.21				
	TOTAL		1,549.42	1,551.77	970.03	1,080.83	2,519.45	2,632.60	92.01	276.05		

NOTES: 1. Circuit 2 L 02, built for 360 kV opn., future circuit 3 L 12

STRBM

CIRCUIT NO.	CIRCUIT LOCATION	REFERENCE DRAWING	POLES POLE km	POLES CIRCUIT km	STEEL TOWERS TOWER km	STEEL TOWERS CIRCUIT km	TOTALS STRUCTURE km	TOTALS CIRCUIT km	UNDERGROUND LINES CIRCUIT km	UNDERGROUND LINES CABLE km	SUBMARINE CABLES CIRCUIT km	SUBMARINE CABLES CABLE km
	DC1 Arnott x VIT	1-HT-18										
	Transmission (Arn. to VIT)											
DC1L3	Arnott x TBT				10.20	10.20	10.20	10.20				
DC1L5	TBT x TRN				6.84	6.84	6.84	6.84			32.51	32.51
DC1L6	TBT x TRN					6.84		6.84			32.51	32.51
DC1L1	TRN x VIT				23.96	23.96	23.96	23.96				
	Metallic Return (VIT to Arn.)											
EL1	VIT x SNE		16.90	16.90			16.90	16.90				
EL2	VIT x SNE			16.90				16.90				
EL3	Arnott x BBE		4.82	4.82			4.82	4.82				
EL4	Arnott x BBE			4.82				4.82				
		DC1-T10-823	21.72	43.44	41.00	47.84	62.72	91.28			65.02	65.02
	DC2 Arnott x VIT	1-HT-18										
	Transmission (Arn. to VIT)											
DC1L4	Arnott x TBT and CPT				4.43	14.63	4.43	14.63				
DC1L8	CPT x TRN				7.11	7.11	7.11	7.11			32.79	32.79
DC1L9	CPT x TRN					7.11		7.11			33.59	33.59
DC1L2	TRN x VIT					23.96		23.96				
	Metallic Return (VIT to Arn.)											
LN1	VIT x TRN		20.44	20.44	2.09	2.09	22.53	22.53				
DC1L7	TRN x TBT					6.84		6.84			32.51	32.51
LN2	TBT x Arnott		3.86	3.86			3.86	3.86				
			24.30	24.30	13.63	61.74	37.93	86.04			98.89	98.89
	Total DC Lines		46.02	67.74	54.63	109.58	100.65	177.32			163.91	163.91

Abbreviations

SNE	Sansum Narrows Electrodes	TBT	Tsawwassen Beach Terminal
BBE	Boundary Bay Electrodes	CPT	Canoe Pass Terminal
TRN	Trincomali Channel		

STRBH

B.C. HYDRO FUTURE PROJECTS PLANNED OR ANTICIPATED

The following major transmission projects are in the design and construction phases:

1. Cheekye-Dunsmuir 500 kV
   In-Service Date (I/S): 1984
2. Revelstoke-Ashton Creek 500 kV
   I/S: 1983
3. Cranbrook-Alberta Border 500 kV
   I/S: 1985
4. Kelly Lake-Nicola 500 kV
   I/S: 1984
5. Ashton Creek-Nicola 500 kV
   I/S: 1984

The following major transmission line projects, planned to be in-service before 2000, may have impacts on agriculture:

1. Creekside-Stave Lake-Ingledow EHV/UHV
   I/S: 1994
2. Homathko Transmission 500 kV
   Earliest I/S: 1996
3. Meager Creek Transmission 230 kV
   I/S: 1988
4. Skeena-Rupert 500 kV
   I/S: 1988
5. Dome LNG/Rupert-Grassy Point 230 kV
   I/S: 1984
6. Williston-Telkwa 500 kV
   I/S: 1989
7. Stikine-Iskut Transmission 500 kV
   I/S: 1993
8. Cluculz Lake-Creekside 500 kV
   I/S: 1995

9. Ashton Creek-Vernon 230 kV
   I/S: 1989

10. Cranbrook-Canal Flats 230 kV
    I/S: 1988

11. Keenleyside-Murphy Creek Transmission 230 kV
    Keenleyside I/S: 1988
    Murphy Creek I/S: 1991

12. Kelly Lake-Cheekye 500 kV
    I/S: 1990

13. 100 Mile House-Clearwater 230 kV
    I/S: 1988

Remarks:

Specific project details depend upon System Planning criteria, technical restraints, environmental mitigation measures and design specifications.

In-service dates and construction schedules depend upon load forecasts, system planning considerations, and the consequent electrical system plan. The dates given are the most probable; but they are subject to change.

The width of rights of way and the width, height and type of structures used depend upon voltage, location, and design requirements. Typical examples are attached.

Obviously, most new transmission lines do not require new substations. However, depending upon system requirements, length and technical restraints, new collector stations, switching stations, and series capacitors may be necessary. In general, new substations are not necessary on 230 kV and 500 kV lines that are shorter than 280 - 320 km.

Joint use and/or parallel use of rights of way with highways, railroads, pipelines, and/or communication systems occur where necessary and/or where advantageous. However, common corridor selection cannot occur until the latter stages of the planning process.

Appendix 1b West Kootenay Power and Light Co. Ltd.

Most of West Kootenay's transmission system is at voltages below 230 kV. The following is a list of their existing and proposed transmission lines as included on the inventory maps.

Line Number	End Points	Voltage	Length R/W with structures
Existing:			
1-8	Trail to South Slocan	8 x 69kV*	40 km-single wood poles
72	Vernon to Hollywood	230 kV	35 km 43m wooden H frame
Proposed:			
	Oliver to Hollywood	230 kV	80 km 43m wooden H frame

*included due to the number of parallel lines.

Appendix 1c Alcan Smelting and Chemicals Ltd.

Alcan operates only the following single electrical transmission line. Proposed lines are considered too remote by Alcan to make public.

Line	Voltage	Length	R/W width	Structures
Kemano-Kitimat	287 kV	5-80 km	90m	self-supporting metal

Pipelines

Appendix 1d Westcoast Transmission Co. Ltd.

Name	Existing or Proposed	Type	Diameter (in)	Length km	Pumps or Compressor
Beaver River-Willow Flats	E	gas	30	521	5
Willow Flats Huntington	E	gas	2 x 30	870	9
Taylor-Willow Flats	E	oil	12	127	2
Willow Flats-Savona	E	gas	12	653	6
Northern Pacific Gas	E	gas	7	780	n/a
Dome Gas					
Alberta-Port Simpson	P	gas	26	855	7
Vancouver Is.					
150 Mile House-Powell River	P	gas	12	381	4
Powell River Comox	P	gas	2 x 11	32	0
Squamish-Penticton	P	gas	11	49	0

Appendix 1e Foothills Pipelines

Proposed

Alaska Highway gas pipeline project

Pipeline	Type	Diameter (in)	Width R/W m	Length	Compressors in Service
Lower Post-Alberta	gas	56	40	715	9
Coleman-Kingsgate	gas			152	

Apendix 1f Inland Natural Gas Co. Ltd.

Inventory - current

Inland Natural Gas Company Limited has 1140 miles of pipe. The pipe diameter varies from 12 inches to 2 inches. We own three compressors in British Columbia. We have rights-of-way varying in width from 60 feet to 10 feet. Most of our system is 23 years old. We occupy common corridors with B.C. Hydro in the Southern Okanagan, and eastern Kootenays.

Future projects planned

We are planning three future projects, a new gas pipeline from Enderby to Revelstoke, approximately 6 to 8 inches in diameter, a new pipeline to Chase and a new pipeline to Pavilion Lake. Our pipelines generally compress to 1000 lbs per sq. in.

Inland Natural Gas Co. Ltd.

Existing:

Pipeline	Type	Diameter (in)	Width R/W (m)	Length (km)	Pumping Stations
Alberta-Burnaby	oil	24	18	697	10

Appendix 1g B.C. Hydro Gas Group

Existing System of Gas Distribution Lines

Proposed:

	Type	Diameter (in)	Width R/W (m)	Length (km)	Compressors in Service
Vancouver Island	gas		18	300	1985

[illegible]

[illegible]

[illegible]

Future projects planned

We are planning three future projects, a new gas pipeline from [illegible] up to [illegible], approximately [illegible] inches in diameter, a new pipeline [illegible] and a new pipeline to [illegible] Lake. Our pipelines [illegible] at [illegible] lbs. per sq. in.

Appendix 2a

B.C. Hydro

T/L (S&LS)

THIS AGREEMENT made as of the day of , 19

BETWEEN:

(hereinafter called "the Owner")

OF THE FIRST PART

AND:

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY, of 970 Burrard Street,
in the City of Vancouver, in the
Province of British Columbia,
V6Z 1Y3,

(hereinafter called "B. C. Hydro")

OF THE SECOND PART

WITNESSETH THAT:

1. The Owner, in consideration of the sum of Dollars ($), of the lawful money of Canada (the receipt and sufficiency whereof is hereby acknowledged) hereby grants unto B. C. Hydro in perpetuity the full and free right, liberty and statutory right of way for B. C. Hydro, its servants, agents and all others the licensees of B. C. Hydro:

HPTAG32

(a) (i) To construct, erect, string, or otherwise install, operate, maintain, remove and replace towers and poles with anchors, guy wires, brackets, crossarms, insulators, transformers and their several attachments and one or more lines of wire, and

(ii) To excavate for, install, operate, maintain, remove and replace (with conduits, cables or pipe of the initial or any other size) one or more underground conduits, whether or not encased by concrete or other protective material, and cables with all necessary attachments and fittings, and aboveground or underground transformers, and one or more underground pipelines of whatsoever kinds or dimensions with necessary and proper aboveground or underground valves, meters and other appliances and fittings and devices for controlling corrosion, all for use in connection with such pipeline or lines,

for the transmission and distribution of electric energy and gas and for communication and aircraft warning purposes (all of which are hereinafter collectively called "the works") upon the portion (hereinafter called "the right of way area") described in Schedule II hereto of the land described in Schedule I hereto (hereinafter called "the land");

(b) (i) To trim or fell all or any trees or growth now or hereafter on the right of way area;

(ii) To clear the right of way area and keep it cleared of all or any part of any trees or growth now or hereafter on the right of way area;

(iii) To clear the right of way area and keep it cleared of all or any part of any buildings or obstructions now or hereafter on the right of way area which might, in the opinion of B. C. Hydro, interfere with or endanger the installation, operation, maintenance, removal or replacement of or access to the works or any part thereof or the operation, use, maintenance or existence of which on the right of way area might, in the opinion of B. C. Hydro, create or increase any hazard to persons;

(c) To ground any buildings, structures, installations or things, by whomsoever owned, from time to time situate anywhere on the right of way area where, in the opinion of B. C. Hydro, such grounding will eliminate or reduce hazard to persons;

(d) To install, maintain and use gates in all fences which now or hereafter shall cross the right of way area;

(e) Generally to do all acts necessary or incidental to the business of B. C. Hydro in connection with the foregoing.

MPTAG35

2. The Owner hereby covenants with B. C. Hydro:

(a) Not to use the right of way area or any part thereof or permit the same to be used for the regular or organised parking of vehicles, without specific written permission from B. C. Hydro;

(b) Not to park or permit to be parked any vehicle or equipment exceeding 25 feet in length under any conductor of 500 kV or higher voltage, unless such vehicle or equipment is properly grounded;

(c) Not to fuel or permit to be fuelled any vehicle or equipment upon the right of way area;

(d) Not to make, place, erect, operate, use or maintain any building, structure, foundation, pavement, excavation, well, pile of material, obstruction, equipment, thing or inflammable substance, (hereinafter called "the Owner's works"), or to plant any growth upon the right of way area, if any such actions, in the opinion of B. C. Hydro:

- (i) might interfere with or endanger the works or any part thereof or the installation, operation, maintenance, removal or replacement of the works or any part thereof; or
- (ii) might obstruct access by B. C. Hydro's servants, agents or licensees to the works or any part thereof; or
- (iii) might by the operation, use, maintenance or existence of the Owner's works on the right of way area create or increase any hazard to persons;

(e) In particular, but without restricting the generality of the foregoing, not to excavate for, erect, construct, maintain or use any swimming pool within the right of way area without specific written permission from B. C. Hydro and then only in compliance with the terms and conditions upon which such permission is granted;

(f) Not to carry out blasting or aerial logging operations on or adjacent to the right of way area unless permission in writing from B. C. Hydro has first been received, which permission shall not be unreasonably withheld;

(g) Not to diminish or substantially to add to the ground cover over such of the works as may be from time to time installed, operated or maintained below the surface of the right of way area and, in particular, without in any way limiting the generality of the foregoing, not to construct open drains or ditches along or across such of the works as may at any time be installed on or under the right of way area;

(h) Not to do or knowingly permit to be done any act or thing which might, in the opinion of B. C. Hydro, in any way whatsoever interfere with or injure the works or any part thereof or impair the operating efficiency thereof or create or increase any hazard to persons.

HPTAG41

3. B. C. Hydro hereby covenants with the Owner:

(a) To pay compensation to the Owner for any damage to any buildings outside the right of way area, and to crops (other than timber), livestock, drains, ditches, culverts, fences, bridges, roads and fruit, nut or ornamental trees anywhere on the land caused by B. C. Hydro in the exercise of any of its rights hereunder and without negligence on the part of the Owner;

(b) To pay all royalties, scaling fees and other charges which may be levied by the Crown against any timber that B. C. Hydro cuts on the land;

(c) To pay compensation to the Owner for all merchantable timber cut or damaged on the land by B. C. Hydro in the exercise of any of its rights hereunder;

(d) That it will, as soon as weather and soil conditions permit and insofar as it is practicable to do so, bury and maintain any underground works installed hereunder so as not to interfere with the drainage or ordinary cultivation and use of the land.

4. It is mutually agreed between the Owner and B. C. Hydro that:

(a) B. C. Hydro shall on or before the day of , 19 , cause a survey of the right of way area to be made and shall deposit the plan of such survey when completed in the proper Land Title Office. Such plan and the survey upon which it is based shall thereafter in all respects establish and define the right of way area and the land, except the right of way area, shall, upon the acceptance of such plan by the said Land Title Office, be discharged from the right, liberty and statutory right of way hereby granted. Upon receipt of the proper fee and application made by B. C. Hydro on behalf of the Owner, the making of which application the Owner hereby authorizes, the Registrar of Titles is hereby authorized to make such entries upon the Register as may be necessary to give effect to the foregoing. The Owner agrees to accept the accuracy of the said survey and the plan thereof without execution or further approval by him;

(b) The amount of any compensation payable under Paragraph 3 hereof shall be such as may be mutually agreed upon between the Owner and B. C. Hydro and in the event of disagreement as may be settled by arbitration pursuant to the Arbitration Act of British Columbia; but no such compensation shall be payable for any damage or cutting for which compensation has theretofore been paid;

(c) The title to all timber cut on the land by B. C. Hydro in the exercise of its rights hereunder shall vest in B. C. Hydro;

(d) This Agreement shall be construed as running with the land and that no part of the fee of the soil shall pass to or be vested in B. C. Hydro under or by these presents;

(e) The expressions "Owner" and "B. C. Hydro" herein contained shall be deemed to include the executors, administrators, successors and assigns of such parties wherever the context so admits;

(f) Where the expression "Owner" includes more than one person, all covenants herein on the part of the Owner shall be construed as being several as well as joint.

IN WITNESS WHEREOF the Owner has caused these presents to be executed as of the day and year first above written.

SIGNED, SEALED AND DELIVERED)
by the Owner in the presence)
of:)

______________________________)
Name)

______________________________)
Address)

______________________________)
Occupation)

MPTRC44

CONSENT

the holder of a registered in
the Land Title Office under charge number
hereby approves of, joins in and consents to the foregoing
grant of right, liberty and statutory right of way and to its
registration in the Land Title Office with priority over the
registration of the said

HPTAG45

PROOF OF EXECUTION BY CORPORATION

I CERTIFY that on the ________ day of ____________________, 19 ,
at ________________________________, in British Columbia,
____,
(whose identity has been proved by the evidence on oath of ____________
____
(state full name, address and occupation)
who is) personally known to me, appeared before me and acknowledged to me that he/she is the authorised signatory of ____________________
____
and that he/she is the person who subscribed his/her name and affixed the seal of the corporation to the instrument, that he/she was authorised to subscribe his/her name and affix the seal to it, and that the corporation existed at the date the instrument was executed by the corporation.

IN TESTIMONY OF WHICH I set my hand and seal of office at
________________________________, in British Columbia, this ______ day
of ______________________________, 19 .

____
A Commissioner for Taking Affidavits for British Columbia
A Notary Public in and for the Province of British Columbia

PROOF OF EXECUTION BY CORPORATION (D.V.A.)

I CERTIFY that on the __________ day of ____________________, 19 ,
at Ottawa, in Ontario, ____,
who is personally known to me, appeared before me and acknowledged to me that he is the authorized signatory of THE DIRECTOR, THE VETERANS' LAND ACT and that he is the person who subscribed his name and affixed the seal of the corporation to the instrument, that he was authorized to subscribe his name and affix the seal to it, and that the corporation existed at the date the instrument was executed by the corporation.

IN TESTIMONY OF WHICH I set my hand and seal of office at Ottawa, in Ontario, this __________ day of ____________________, 19 .

____
A Commissioner for Taking Affidavits for Ontario
A Notary Public in and for the Province of Ontario

STATUTORY DECLARATION WHERE ATTORNEY IS NOT A CORPORATION

I, ____,
of ________________________, in British Columbia, solemnly declare that:

1. I am the attorney for
under a power of attorney filed under the LAND TITLE ACT. ____________________

2. I am the person who subscribed the name of ____________________
________________________ and my name in the instrument as a transferor.

3. At the time of the execution of the instrument the power of attorney had not been revoked by or on behalf of ____________________
and I had not received any notice or information of the death, disability or bankruptcy of ____________________.

OR, IF THE PRINCIPAL OF THE POWER OF ATTORNEY IS A CORPORATION, SUBSTITUTE FOR 3 ABOVE:

3. At the time of execution of the instrument the power of attorney had not been revoked by or on behalf of ____________________,
that ____________________ is legally entitled to hold and dispose of land in British Columbia, and I had not received any notice or information of the bankruptcy or dissolution of ____________________.

4. I know the contents of the instrument and subscribed the name of
____ to it voluntarily as the free act of the transferor.

And I make this solemn declaration conscientiously believing it to be true, and knowing that it is of the same force and effect as if made under oath.

Declared before me at ____________,)
in British Columbia, this ________ day of)
________________ 19 .)

__________________________) __________________________
A Commissioner for Taking Affidavits for British Columbia
A Notary Public in and for the Province of British Columbia

[illegible]

CERTIFICATE OF ACKNOWLEDGMENT OF TRANSFEROR

I CERTIFY that on the ________ day of ____________________, 19 . at ______________________________, in British Columbia, ______________________________ (whose identity has been proved by the evidence on oath of ____________________ ______________________________ (state full name, address and occupation) who is) personally known to me, appeared before me and acknowledged to me that he/she/they is(are) the person(s) mentioned in this instrument as a transferor (or attorney of a transferor), that his/her/their name(s) is(are) subscribed to it, that he/she/they know(s) the contents of the instrument and executed it voluntarily, and is(are) of the age of 19 years or more.

IN TESTIMONY OF WHICH I set my hand and seal of office at ____________ ____________________, in British Columbia, this _____ day of ____________, 19

____

A Commissioner for Taking Affidavits for British Columbia

A Notary Public in and for the Province of British Columbia

Dated ____________________ 19

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

and

STATUTORY RIGHT OF WAY

Properties Division
British Columbia Hydro and
Power Authority
[illegible] - 1045 Howe Street
Vancouver, B. C. V6Z 2B1

AFFIDAVIT OF WITNESS

I, ______________________________, of ____________________, in British Columbia, make oath and say:

1. I was present and saw this instrument duly signed and executed by ______________________________ the party(ies) to it, for the purposes named in it.

2. The instrument was executed at ____________________.

3. I know the party(ies), who is(are) 19 years old or more.

4. I am the subscribing witness to the instrument and am 16 years old or more.

Sworn before me at ______________,)
in British Columbia, this ______ day of)
____________________, 19 .)

______________________________) ______________________________

A Commissioner for Taking Affidavits
for British Columbia
A Notary Public in and for the Province
of British Columbia

870-449

APPENDIX 2

Standard Right-of-Way Agreements

2a B.C. Hydro
  Electrical Transmission
  Gas Pipelines

  (Several alternate forms are included.
  Please note repetitive page numbers.)

2b West Kootenay Power and Light
  Statutory Right-of-Way

2c Westcoast Transmission Co. Ltd.
  Grant of Right-of-way

2d Inland Natural Gas
  Grant-of-Easement and Statutory Right of Way.

THIS AGREEMENT made as of the day of
, 19

BETWEEN:

(hereinafter called "the Owner")

OF THE FIRST PART

AND:

BRITISH COLUMBIA HYDRO AND POWER
AUTHORITY, of 970 Burrard Street,
in the City of Vancouver, in the
Province of British Columbia,
V6Z 1Y3,

(hereinafter called "B. C. Hydro")

OF THE SECOND PART

WITNESSETH THAT:

1. The Owner, in consideration of the sum of Dollars ($), of the lawful money of Canada (the receipt and sufficiency whereof is hereby acknowledged) hereby grants unto B. C. Hydro in perpetuity the full and free right, liberty and statutory right of way for B. C. Hydro, its servants, agents and all others the licensees of B. C. Hydro:

(a) To excavate for, install, operate, maintain, remove and replace (with pipe of the initial or any other size) one or more underground pipelines of whatsoever kinds or dimensions with necessary and proper aboveground or underground valves, meters, anchors and other appliances and fittings, and devices for controlling corrosion, all for use in connection with such pipeline or lines for the transmission and distribution of gas (all of which are hereinafter collectively called "the works") upon and within the portion described in Schedule II hereto (hereinafter called "the right of way area") of the land described in Schedule I hereto (hereinafter called "the land");

(b) (i) To trim or fell all or any trees or growth now or hereafter on the right of way area;

(ii) To clear the right of way area and keep it cleared of all or any part of any trees or growth now or hereafter on the right of way area;

(iii) To clear the right of way area and keep it cleared of all or any part of any buildings or obstructions now or hereafter on the right of way area which might, in the opinion of B. C. Hydro, interfere with or endanger the installation, operation, maintenance, removal or replacement of or access to the works or any part thereof or the operation, use, maintenance or existence of which on the right of way area might, in the opinion of B. C. Hydro, create or increase any hazard to persons;

(c) To install marking posts with warning signs attached to mark the location of the works;

(d) To install, maintain and use gates in all fences which now or hereafter shall cross the right of way area;

(e) To use such portion of the land alongside the right of way area as may be reasonably necessary in connection with the excavation for, installation, replacement, removal, repair and maintenance of the works or any part thereof;

(f) Generally to do all acts necessary or incidental to the business of B. C. Hydro in connection with the foregoing.

(a) To excavate for, install, operate, maintain, remove and replace (with pipe of the initial or any other size) one or more underground pipelines of whatsoever kinds or dimensions with necessary and proper aboveground or underground valves, meters, anchors and other appliances and fittings, and devices for controlling corrosion, all for use in connection with such pipeline or lines for the transmission and distribution of gas (all of which are hereinafter collectively called "the works") upon and within the land described in the Schedule hereto (hereinafter called "the land");

(b) (i) To trim or fell all or any trees or growth now or hereafter on the right of way area (as hereinafter defined);

(ii) To clear the right of way area and keep it cleared of all or any part of any trees or growth now or hereafter on the right of way area;

(iii) To clear the right of way area and keep it cleared of all or any part of any buildings or obstructions now or hereafter on the right of way area which might, in the opinion of B. C. Hydro, interfere with or endanger the installation, operation, maintenance, removal or replacement of or access to the works or any part thereof or the operation, use, maintenance or existence of which on the right of way area might, in the opinion of B. C. Hydro, create or increase any hazard to persons;

(c) To install marking posts with warning signs attached to mark the location of the works;

(d) To install, maintain and use gates in all fences which now or hereafter shall cross the right of way area;

(e) To use such portion of the land alongside the right of way area as may be reasonably necessary in connection with the excavation for, installation, replacement, removal, repair and maintenance of the works or any part thereof;

(f) Generally to do all acts necessary or incidental to the business of B. C. Hydro in connection with the foregoing;

on the understanding that, as soon as B. C. Hydro has constructed the works or any of them on the land, the right, liberty and statutory right of way hereby granted shall thereupon and thereafter be confined and restricted to a portion of the land (herein referred to as "the right of way area") comprising a strip of the land which will be located approximately as shown outlined in red on the plan attached hereto and will be precisely determined by a survey to be made by a British Columbia Land Surveyor at the expense of B. C. Hydro.

(a) To excavate for, install, operate, maintain, remove and replace (with pipe of the initial or any other size) one or more underground pipelines of whatsoever kinds or dimensions with necessary and proper aboveground or underground valves, meters, anchors and other appliances and fittings, and devices for controlling corrosion, all for use in connection with such pipeline or lines for the transmission and distribution of gas (all of which are hereinafter collectively called "the works") upon and within the land described in the Schedule hereto (hereinafter called "the land");

(b) (i) To trim or fell all or any trees or growth now or hereafter on any portion or portions of the land lying within three (3) metres of a line formed by raising or dropping perpendiculars to the surface of the ground from the outermost points of any of the works (which portions are hereinafter together called "the adjacent areas");

(ii) To clear the adjacent areas and keep them cleared of all or any part of any trees or growth now or hereafter on the adjacent areas;

(iii) To clear the adjacent areas and keep them cleared of all or any part of any buildings or obstructions now or hereafter on the adjacent areas which might, in the opinion of B. C. Hydro, interfere with or endanger the excavation for, installation, operation, maintenance, removal or replacement of or access to the works or any part thereof or the operation, use, maintenance or existence of which on the adjacent areas might, in the opinion of B. C. Hydro, create or increase any hazard to persons;

(c) To install marking posts with warning signs attached to mark the location of the works;

(d) To install, maintain and use gates in all fences which now or hereafter shall cross the adjacent areas;

(e) Generally to do all acts necessary or incidental to the business of B. C. Hydro in connection with the foregoing.

2. The Owner hereby covenants with B. C. Hydro:

(a) Not to make, place, erect, operate, use or maintain any pipe, wire, cable, utility, building, structure, foundation, excavation, pavement, well, pile of material, obstruction or equipment, (hereinafter called "the Owner's works), or to plant any growth exceeding two (2) metres in height upon the right of way area, if any such actions, in the opinion of B. C. Hydro:

(i) might interfere with or endanger the excavation for, installation, operation, maintenance, removal or replacement of the works or any part thereof; or

(ii) might obstruct access by B. C. Hydro's servants, agents or licensees to the works or any part thereof; or

(iii) might by the operation, use, maintenance or existence of the Owner's works on the right of way area create or increase any hazard to persons, vehicles or equipment; or

(iv) might interfere with or endanger the works or any part thereof;

(b) Not to carry out blasting on or adjacent to any portion of the right of way area unless permission in writing from B. C. Hydro has first been received, which permission shall not be unreasonably withhold;

(c) Not to use the right of way area or any part thereof or permit the same to be used for the regular or organized parking of vehicles without specific written permission from B. C. Hydro and then only in compliance with the terms and conditions upon which such permission is granted;

(d) Not to diminish or substantially to add to the ground cover over such of the works as may be from time to time installed, operated or maintained below the surface of the right of way area and, in particular, without in any way limiting the generality of the foregoing, not to construct open drains or ditches along or across such of the works as may at any time be installed under the right of way area;

(e) Not to do or knowingly permit to be done any act or thing which might, in the opinion of B. C. Hydro, in any way whatsoever interfere with or injure or endanger the works or any part thereof or impair the operating efficiency thereof or create or increase any hazard to persons.

HPTAG25

2. The Owner hereby covenants with B. C. Hydro:

(a) Not to make, place, erect, operate, use or maintain any pipe, wire, cable, utility, building, structure, foundation, excavation, pavement, well, pile of material, obstruction or equipment, (hereinafter called "the Owner's works"), or to plant any growth exceeding two (2) metres in height upon the adjacent areas, if any such actions, in the opinion of B. C. Hydro:

(i) might interfere with or endanger the excavation for, installation, operation, maintenance, removal or replacement of the works or any part thereof; or

(ii) might obstruct access by B. C. Hydro's servants, agents or licensees to the works or any part thereof; or

(iii) might by the operation, use, maintenance or existance of the Owner's works on the adjacent areas create or increase any hazard to persons, vehicles or equipment; or

(iv) might interfere with or endanger the works or any part thereof;

(b) Not to carry out blasting on or adjacent to any portion of the adjacent areas unless permission in writing from B. C. Hydro has first been received, which permission shall not be unreasonably withheld;

(c) Not to use the adjacent areas or any part thereof or permit the same to be used for the regular or organized parking of vehicles without specific written permission from B. C. Hydro and then only in compliance with the terms and conditions upon which such permission is granted;

(d) Not to diminish or substantially to add to the ground cover over such of the works as may be from time to time installed, operated or maintained below the surface of the land and, in particular, without in any way limiting the generality of the foregoing, not to construct open drains or ditches along or across such of the works as may at any time be installed under the land;

(e) Not to do or knowingly permit to be done any act or thing which might, in the opinion of B. C. Hydro, in any way whatsoever interfere with or injure or endanger the works or any part thereof or impair the operating efficiency thereof or create or increase any hazard to persons.

HPTAG26

3. B. C. Hydro hereby covenants with the Owner:

(a) To pay compensation to the Owner for any damage to any buildings outside the right of way area, and to crops (other than timber), livestock, drains, ditches, culverts, fences, bridges, roads and fruit, nut or ornamental trees anywhere on the land caused by B. C. Hydro in the exercise of any of its rights hereunder and without negligence on the part of the Owner;

(b) To pay all royalties, scaling fees and other charges which may be levied by the Crown against any timber that B. C. Hydro cuts on the land;

(c) To pay compensation to the Owner for all merchantable timber cut or damaged on the land by B. C. Hydro in the exercise of any of its rights hereunder;

(d) That it will, as soon as weather and soil conditions permit and insofar as it is practicable to do so, bury and maintain the works installed hereunder so as not to interfere with the drainage or ordinary cultivation and use of the land;

3. B. C. Hydro hereby covenants with the Owner:

(a) To pay compensation to the Owner for any damage to any buildings outside the adjacent areas and to crops (other than timber), livestock, drains, ditches, culverts, fences, bridges, roads and fruit, nut or ornamental trees anywhere on the land caused by B. C. Hydro in the exercise of any of its rights hereunder and without negligence on the part of the Owner;

(b) To pay all royalties, scaling fees and other charges which may be levied by the Crown against any timber that B. C. Hydro cuts on the land;

(c) To pay compensation to the Owner for all merchantable timber cut or damaged on the land by B. C. Hydro in the exercise of any of its rights hereunder;

(d) That it will, as soon as weather and soil conditions permit and insofar as it is practicable to do so, bury and maintain the works installed hereunder so as not to interfere with the drainage or ordinary cultivation and use of the land;

4. It is mutually agreed between the Owner and B. C. Hydro that:

(a) The amount of any compensation payable under paragraph 3 hereof shall be such as may be mutually agreed upon between the Owner and B. C. Hydro and in the event of disagreement as may be settled by arbitration pursuant to the Arbitration Act of British Columbia, but no such compensation shall be payable for any damage or cutting for which compensation has theretofore been paid;

(b) The title to all timber cut on the land by B. C. Hydro in the exercise of its rights hereunder shall vest in B. C. Hydro;

(c) This Agreement shall be construed as running with the land and that no part of the fee of the soil shall pass to or be vested in B. C. Hydro under or by this Agreement;

(d) The expressions "Owner" and "B. C. Hydro" herein contained shall be deemed to include the executors, administrators, successors and assigns of such parties wherever the context so admits;

(e) Where the expression "Owner" includes more than one person, all covenants herein on the part of the Owner shall be construed as being several as well as joint; and

(f) Wherever the singular and masculine are used in this Agreement they shall be construed as meaning the plural or the feminine or body corporate where the context or the parties hereto so require.

IN WITNESS WHEREOF the Owner has caused these presents to be executed as of the day and year first above written.

SIGNED, SEALED AND DELIVERED)
by the Owner in the presence)
of)

____________________________)
NAME)

____________________________)
ADDRESS)

____________________________)

____________________________)
OCCUPATION)

MPTAG29

(e) Not to install, maintain or replace any works upon or within the land under the terms of this Agreement other than those works located or to be located as shown coloured red or within the red outline (as the case may be) upon the attached print of B. C. Hydro Drawing Number unless permission from the Owner has first been received which permission shall not unreasonably be withheld.

4. It is mutually agreed between the Owner and B. C. Hydro that:

(a) The amount of any compensation payable under paragraph 3 hereof shall be such as may be mutually agreed upon between the Owner and B. C. Hydro and in the event of disagreement as may be settled by arbitration pursuant to the Arbitration Act of British Columbia, but no such compensation shall be payable for any damage or cutting for which compensation has theretofore been paid;

(b) The title to all timber cut on the land by B. C. Hydro in the exercise of its rights hereunder shall vest in B. C. Hydro;

(c) This Agreement shall be construed as running with the land and that no part of the fee of the soil shall pass to or be vested in B. C. Hydro under or by this Agreement;

(d) The expressions "Owner" and "B. C. Hydro" herein contained shall be deemed to include the executors, administrators, successors and assigns of such parties wherever the context so admits;

(e) Where the expression "Owner" includes more than one person, all covenants herein on the part of the Owner shall be construed as being several as well as joint; and

(f) Wherever the singular and masculine are used in this Agreement they shall be construed as meaning the plural or the feminine or body corporate where the context or the parties hereto so require.

IN WITNESS WHEREOF the Owner has caused these presents to be executed as of the day and year first above written.

SIGNED, SEALED AND DELIVERED)
by the Owner in the presence)
of)
)
)
______________________________)
NAME)
)
)
______________________________)
ADDRESS)
)
)
______________________________)
)
)
______________________________)
OCCUPATION)

HPTAG30

4. It is mutually agreed between the Owner and B. C. Hydro that:

(a) B. C. Hydro shall, on or before the day of , 19 , cause a survey of the right of way area to be made and shall deposit the plan of such survey when completed in the proper Land Title Office. Such plan and the survey upon which it is based shall thereafter in all respects establish and define the right of way area and the land, except the right of way area, shall upon the acceptance of such plan by the said Land Title Office be discharged from the right, liberty and statutory right of way hereby granted. Upon receipt of the proper fee and application made by B. C. Hydro on behalf of the Owner, the making of which application the Owner hereby authorizes, the Registrar of Titles is hereby authorized to make such entries upon the Register as may be necessary to give effect to the foregoing. The Owner agrees to accept the accuracy of the said survey and the plan thereof without execution or further approval by him;

(b) The amount of any compensation payable under paragraph 3 hereof shall be such as may be mutually agreed upon between the Owner and B. C. Hydro and in the event of disagreement as may be settled by arbitration pursuant to the Arbitration Act of British Columbia, but no such compensation shall be payable for any damage or cutting for which compensation has theretofore been paid;

(c) The title to all timber cut on the land by B. C. Hydro in the exercise of its rights hereunder shall vest in B. C. Hydro;

(d) This Agreement shall be construed as running with the land and that no part of the fee of the soil shall pass to or be vested in B. C. Hydro under or by this Agreement;

(e) The expressions "Owner" and "B. C. Hydro" herein contained shall be deemed to include the executors, administrators, successors and assigns of such parties wherever the context so admits;

(f) Where the expression "Owner" includes more than one person, all covenants herein on the part of the Owner shall be construed as being several as well as joint; and

(g) Wherever the singular and masculine are used in this Agreement they shall be construed as meaning the plural or the feminine or body corporate where the context or the parties hereto so require.

IN WITNESS WHEREOF the Owner has caused these presents to be executed as of the day and year first above written.

SIGNED, SEALED AND DELIVERED)
by the Owner in the presence)
of)
)
______________________________)
NAME)
)
______________________________)
ADDRESS)
)
______________________________)
OCCUPATION)

HPTAG31

Appendix 2b

West Kootenay Power and Light Co. Ltd.

LAND TITLE ACT FOR 17 (SECTION 152) APPLICATION

Nature of charge:

STATUTORY RIGHT-OF-WAY

Address of person entitled to be registered if different from that shown in instrument:

HEREWITH FEES OF. $____________________

True Value: $________________________

Full name, postal address and telephone number of person presenting instrument for registration:

Daniel Joseph Bachynski
Land Agent
West Kootenay Power and Light Company,
Limited, P.O. Box 130
Trail, B.C. V1R 4L4
Telephone: 368-3321

____
Signature of Applicant (Agent)

STATUTORY RIGHT-OF-WAY

THIS INDENTURE made this day of , 19 .

BETWEEN:

(hereinafter called "the Transferor")
OF THE FIRST PART

AND:

WEST KOOTENAY POWER AND LIGHT COMPANY, LIMITED
a public utility incorporated by Special Act of
the Legislature of the Province of British Columbia,
having its head office at Waneta Plaza, 8100 Rock
Island Highway, Trail, British Columbia, V1R 4N7

(hereinafter called "the Company")
OF THE SECOND PART

WITNESSES THAT WHEREAS this Statutory Right-of-Way is necessary for the operation and maintenance of the Company's undertaking;

In consideration of the sum of
($) now paid by the Company, the receipt and sufficiency of which is hereby acknowledged, the Transferor HEREBY GRANTS AND CONVEYS unto the Company, its agents, servants, licencees and workmen, and all other persons acting on its or their behalf, with or without such vehicles or equipment as it or they may consider necessary, an Easement by way of Statutory Right-of-Way for full, free and uninterrupted ingress or egress at all times hereafter by day or night to, through, over and under all that certain parcel of land, situate, lying and being in the

in the Province of British Columbia, particularly described as

AND FURTHER the Transferor HEREBY GRANTS unto the Company a Right-of-Way (hereinafter called "the right-of-way") on and under that part of the said land shown on

to install, construct and maintain transmission and distribution lines and communciation facilities and such equipment as the Company considers necessary or beneficial (hereinafter called "the facilities") for their operation and maintenance, with the right to dig up the soil and rock thereof for the installation of the facilities, and from time to time to inspect, repair, remove, alter, renew and replace the same or any part or parts thereof, and to clear the right-of-way of such growth and material that in the Company's opinion might interfere with or damage the facilities.

Form 101 T&D

Reserving, however, unto the Transferor the right to cultivate or otherwise use the said land and the right to compensation for any damage done by the Company, its agents, servants and workmen to fences and to crops thereon.

The Transferor covenants that he will not at any time hereafter plant any trees or climbing vines on the right-of-way or do any act of whatever nature that will jeopardize or interfere with the operation or maintenance of the said line or other property of the Company on the right-of-way; that he will not erect thereon any buildings or structures, and that he will cause no damage to nor interfere with the work or structures of the Company thereon.

Notwithstanding any rule of law or equity, the facilities shall at all times remain the property of the Company notwithstanding that the same may be annexed or fixed to the free-hold, and shall at any time and from time to time be removable in whole or in part by the Company, its successors and assigns.

The Transferor may install a fence within the right-of-way area provided it does not interfere with the operation or maintenance of the facilities. The Company will not be liable for any costs for repair to the fence if it is damaged during the installation or maintenance of the facilities.

The Company will be liable for any damage caused to crops by its agents, servants, licencees or workmen on the said land. The Company will be responsible for the acts of any of its agents, servants, licencees or workmen or persons claiming under it, but not for the acts of any other persons.

The Transferor convenants that he has the right to enter into this Indenture, and covenants that he will not at any time hereafter do any act that will jeopardize or interfere with the facilities or the rights granted herein.

The Transferor agrees that the Company may provide a communications company with all the rights under this Statutory Right-of-Way to install and maintain communications facilities within the area of the right-of-way either together with the Company, or in such other conduits or facilities as may be installed by such communications company with full right of ingress and egress as is herein granted to the Company.

The rights, privileges and easement hereby granted are and shall be of the same force and effect as a covenant running with the land, and this Indenture shall enure to the benefit of and be binding upon the parties hereto, their heirs, administrators, successors and assigns, and wherever the singular or masculine is used herein, it shall be construed as if the feminine, plural or neuter, as the case may be, had benn used wherever the context or the parties hereto so require.

IN WITNESS WHEREOF the Transferor has caused these presents to be duly executed as of the day and year first above written.

The Corporate Seal of the Transferor)
was hereunto affixed in the)
presence of:)

________________________________)
Authorized Signatory)

________________________________)

Form 101 T&D

DATED 19 82

— To —

WEST KOOTENAY POWER AND LIGHT
COMPANY, LIMITED

STATUTORY RIGHT-OF-WAY

Filed for Registration at the
Land Title Office on the
day of , 19 ,
under Number

Daniel Joseph Bachynski
West Kootenay Power and Light
Company, Limited
Box 130, 8100 Rock Island Highway,
TRAIL, British Columbia
V1R 4L4

Telephone: 368-3321

File No.

[illegible]
[illegible]

Appendix 2c

Westcoast Transmission Co. Ltd.

Grant of Right-of-way

Policies

Right-of-way Acquisition and setlement of damage claims.

Dated A.D. 19

- and -

WESTCOAST TRANSMISSION
COMPANY LIMITED

Grant of Right-of-way

WESTCOAST TRANSMISSION
COMPANY LIMITED

LAND REGISTRY ACT
FORM 17
(Section 220)
APPLICATION

Charge
True Value
Value Fees of $
Full name, address and telephone number of person presenting application

Nature of Charge
Grant Right of Way
Address of person entitled to be registered as owner, if different than shown in instrument

Signature of Applicant
(Solicitor or Agent)

R/W No.

WESTCOAST TRANSMISSION COMPANY LIMITED
GRANT OF RIGHT-OF-WAY
BRITISH COLUMBIA

The undersigned,
of in the Province of British Columbia, (hereinafter called the "Grantor"), [illegible] in the Province of British Columbia, [illegible]

(hereinafter called the "Lands of Grantor")
in consideration of the sum of Ten Dollars [illegible] of lawful money of Canada [illegible] Westcoast Transmission Company Limited, a body corporate with Head Office at the City of Vancouver, in the Province of British Columbia, (hereinafter referred to as the "Grantee"), [illegible]

Grantor and Grantee agree that as soon as Grantee shall have laid down the initial pipe [illegible] the "Right-of-Way"):

[illegible]

[illegible]

[illegible]

FIRST: [illegible]

The Registrar is authorized to make such entries in the register as may be necessary to give effect to the foregoing.

[illegible]

SECOND: [illegible] Dollars (\$) per acre of the portion of the Lands of Grantor comprised in the said Right-of-Way.

THIRD: [illegible]

FOURTH: [illegible] upon the Grantee.

FIFTH: The Grantee shall compensate the Grantor and/or other interested parties, as their respective interests for the same being may appear, for damage done to any buildings, crops, pasture, fences, drains, timber, livestock or other improvements on the Lands of Grantor by reason of the exercise of the rights hereinbefore granted.

SIXTH: The Grantee (insofar as it is practicable so to do) shall bury and maintain all pipe and other installations so as not to interfere unreasonably with the drainage or ordinary cultivation of the Lands of Grantor.

SEVENTH: Notwithstanding any rule of law or equity, the pipe (which term shall include all pipe lines, drips, valves, fittings, connections, meters and all other equipment and appurtenances brought on to and/or erected upon or buried in or under said Right-of-Way by the Grantee) shall at all times remain the property of the Grantee notwithstanding that the same may be annexed or affixed to the freehold and shall at any time and from time to time be removable in whole or in part by the Grantee, its successors and assigns.

EIGHTH: In the event the Grantee abandons the pipe line or pipe lines, the Grantee may, if it so elects, leave the pipe or any part thereof in place, but will restore the surface of the Lands of Grantor to the same condition, so far as may be practicable so to do, as the same were in prior to the entry thereon and the use thereof by the Grantee.

NINTH: The Grantee performing and observing the covenants and conditions on its part to be performed and observed, shall and may peaceably hold and enjoy the rights, liberties, privileges and easements hereby granted without hindrance, molestation or interruption on the part of the Grantor or of any person claiming by, through, under or in trust for the Grantor.

TENTH: All notices to be given hereunder may be given by registered letter addressed to the Grantor at

and to the Grantee at 1333 West Georgia Street, Vancouver, British Columbia, V6E 3K9 or such other address as the Grantor and the Grantee may respectively from time to time designate in writing, and any such notice shall be deemed to have been given to and received by the addressee three (3) days after the mailing thereof, postage prepaid and registered.

ELEVENTH: Neither this instrument nor anything herein contained shall affect or prejudice the Grantee's statutory rights, powers or licence, to acquire the said Right-of-Way or any other portion or portions of the Lands of Grantor as may be provided for by law, which rights the Grantee may exercise in its discretion.

TWELFTH: Nothing herein contained shall be deemed to vest in the Grantee any title to mines, ores, metals, coal, slate, oil, gas or other minerals in or under the lands comprising the said Right-of-Way, except only the parts thereof that are necessary to be dug, carried away or used in the construction of the works of the Grantee.

THIRTEENTH: If at the date hereof the Grantor is not the sole owner of the Lands of Grantor, this Instrument shall nevertheless bind the Grantor to the full extent of his interest therein, and if he shall later acquire a greater or the entire interest, this Instrument shall likewise extend to such after-acquired interests.

FOURTEENTH: The rights, liberties, privileges and easements hereby granted are and shall be of the same force and effect to all intents and purposes as a covenant running with the land and this Instrument, including all the covenants and conditions herein contained, shall extend to, be binding upon and enure to the benefit of the heirs, executors, administrators, successors-in-title and assigns of the parties hereto respectively and wherever the singular or masculine is used, it shall be construed as if the plural or the feminine or the neuter, as the case may be, had been used, where the context or the party or parties hereto so require, and the rest of the sentence shall be construed as if the grammatical and terminological changes thereby rendered necessary had been made.

IN WITNESS WHEREOF these presents have been executed by the Grantor and the Grantee, this

day of , 19 .

SIGNED, SEALED AND DELIVERED
by the Grantor in the presence of:

Name **Grantor** **(Seal)**

Address **Address**

Occupation

SIGNED, SEALED AND DELIVERED
by the Grantor in the presence of:

Name **Grantor** **(Seal)**

Address **Address**

Occupation

WESTCOAST TRANSMISSION COMPANY LIMITED
Grantee

Per:
Land Agent

MEMORANDUM AS TO ENCUMBRANCES, LIENS AND INTERESTS

CONSENT

I/We the undersigned, being the holder(s) of an encumbrance or entitled to a lien or interest referred to in the memorandum above written, for valuable consideration, receipt of which is hereby acknowledged, HEREBY CONSENT to the granting of the within Right-of-Way and agree that the same shall be binding upon and take priority over me/our interest in or charge upon the said lands.

SIGNED, SEALED AND DELIVERED
in the presence of:

(Seal)

(Seal)

(Seal)

LAND TITLE ACT

FORM 6
(Section 46)

PROOF OF EXECUTION BY CORPORATION

I certify that on the .... day of ...., 19 ...., at ....
in British Columbia, ...
(*whose identity has been proved by the evidence on oath of ....
.... who is) personally known to me, appeared
(State full name, address, and occupation)
before me and acknowledged to me that he/she is the authorized signatory of ....
.... and that he/she is the person who subscribed his/her name and affixed the seal of the corporation to the instrument, that he/she was authorized to subscribe his/her name and affix the seal to it, †(and that the corporation existed at the date the instrument was executed by the corporation.)

In testimony of which I set my hand and seal of office at ....,
this .... day of ...., 19 .

‡ ....

*Where the person making the acknowledgment is personally known to the officer taking it, strike out these words in brackets.
†These words in brackets may be added, if the applicant wishes the registrar to exercise his discretion under section 162 (3) not to call for further evidence of the existence of the corporation.
‡Write name and qualifications under section 48, e.g., A Commissioner for Taking Affidavits for British Columbia.

LAND TITLE ACT

FORM 2
(Sections 43 (a) and 44 (a))

AFFIDAVIT OF WITNESS

I, ..., of
.... in
British Columbia, make oath and say:

1. I was present and saw this instrument duly signed and executed by ....
.............................., the party(ies) to it, for the purposes named in it.
2. The instrument was executed at ....
3. I know the party(ies), who is(are) 19 years old or more.
4. I am the subscribing witness to the instrument and am 16 years old or more.

Sworn before me at ....
in British Columbia, this .... day
of ...., 19 ....

* ....

*Write name and qualifications under section 48, e.g., A Commissioner for Taking Affidavits for British Columbia.
NOTE—This affidavit must be sworn by a witness who is not a party to the instrument.

LAND TITLE ACT

FORM 2
(Sections 43 (a) and 44 (a))

AFFIDAVIT OF WITNESS

I, ..., of
.... in
British Columbia, make oath and say:

1. I was present and saw this instrument duly signed and executed by ....
.............................., the party(ies) to it, for the purposes named in it.
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4. I am the subscribing witness to the instrument and am 16 years old or more.

Sworn before me at ....
in British Columbia, this .... day
of ...., 19 ....

* ....

*Write name and qualifications under section 48, e.g., A Commissioner for Taking Affidavits for British Columbia.
NOTE—This affidavit must be sworn by a witness who is not a party to the instrument.

WESTCOAST TRANSMISSION COMPANY LIMITED **PIPELINE OPERATION AND MAINTENANCE MANUAL**	5.1
	EFFECTIVE DATE July 31, 1981
RIGHT-OF-WAY ACQUISITION AND SETTLEMENT OF DAMAGE CLAIMS	PAGE No 1 OF 4
	MANAGEMENT APPROVED
	SUPERSEDES October 11, 1980

SCOPE: Covers the general philosphy of acquiring rights-of-way and the settlement of damage claims.

PURPOSE: To provide operation and maintenance personnel with theory pertaining to rights-of-way acquisition and settlement of damage claims.

When acquiring a right-of-way for a pipeline, the requirement is not the exclusive use of the land but the right to construct, operate and maintain a pipeline. The word "Pipe Line" as commonly used in the industry, and as defined in the National Energy Board Act is as:

> "Pipe Line" means a line for the transmission of gas or oil connecting a province with any other or others of the provinces, or extending beyond the limits of a province, and includes all branches, extensions, tanks, reservoirs, storage facilities, pumps, racks, compressors, loading facilities, interstation systems of communication by telephone, telegram or radio, and real and personal property and works connected therewith."

When a right-of-way is required for big inch it is usually 60 or 100 feet in width (the National Energy Board specifies 60 feet unless otherwise applied for) and this acquired right-of-way is utilized for the construction, operation and maintenance of the "Pipe Line".

It must also be assumed when acquiring the right-of-way for a pipeline use, good agricultural, industrial, or residential property does not support a pipeline any better or worse than vacant unsurveyed Crown land. The cost of right-of-way, however, varies with the market value of the land in any given area and is not related to the cost of the pipeline itself, or to the product it carries, or the financial gain which may be derived therefrom. What percentage, in relation to the whole, is paid for the right-of-way is related to how the restrictions, placed on the land once the right-of-way is impressed, effect the market value of the land. Common restrictions imposed by pipeline companies are: "The Owner of the land shall not excavate, drill, install, erect or permit to be excavated, drilled, installed or erected on or under the right-of-way any pit, well, foundation, pavement or other structure or installation without the prior written consent of the pipeline company."

Other common restrictions are placed by the controlling government agencies covering the crossing of pipeline with roads, railways and utilities without the consent of the controlling authority and pipeline company. Therefore, the cost of acquiring right-of-way is normally a small percentage of the market value of the land in remote areas, however, it can exceed the market value in industrial, urban or even intensive agricultural areas.

WESTCOAST TRANSMISSION COMPANY LIMITED **PIPELINE OPERATION AND MAINTENANCE MANUAL**	REFERENCE No 5.1 EFFECTIVE DATE July 31, 1981	
SUBJECT RIGHT-OF-WAY ACQUISITION AND SETTLEMENT OF DAMAGE CLAIMS	PAGE No 3 OF 4 SUPERSEDES October 11, 1980	MANAGEMENT APPROVED

Traditionally a right-of-way is acquired for as long as the pipeline is in operation, and the acquisition price is paid to the land owner or Crown as a lump sum payment at the time of acquiring.

In addition to the payment to construct, operate and maintain a pipeline right-of-way, pipeline companies have always accepted the philosophy that damages should be paid to the land Owner, Crown and/or tenant for all damages to the land caused by the construction, operation and maintenance of the pipeline. A common damage clause states "the pipeline company shall pay the Owner and or other interested parties, as their respective interest may from time to time appear, for all damage done to any buildings, crops, pastures, fences, drains, timber, livestock or other improvements caused by the construction, operation and maintenance of a pipeline".

The theory is basically that a land Owner or tenant should be compensated in a manner that he is equally as well off after the construction of the pipeline accross his land as he was prior to the pipeline being constructed. As well, he should not suffer inconvenience because of above ground facilities necessary to be constructed by the pipeline company, nor should he suffer should the pipeline cause him damage during the entire time it is in operation, or at any time his land need be disturbed by the pipeline company's maintenance crews.

WESTCOAST TRANSMISSION COMPANY LIMITED

PIPELINE OPERATION AND MAINTENANCE MANUAL

REFERENCE No 5.1

EFFECTIVE DATE July 31, 1981

PAGE No 4 OF 4

MANAGEMENT APPROVED

SUPERSEDES October 11, 1981

SUBJECT

RIGHT-OF-WAY ACQUISITION AND SETTLEMENT OF DAMAGE CLAIMS

Settling damage claims fairly and equitably varies greatly with the use of land. For instance in an urban area if the rights given for a right-of-way restrict the land from its normal use presumably satisfactory payment has been made for the right-of-way and there is little actual damage resulting from construction requiring additional compensation. This applies to industrial areas as well. In farm land the type of crops grown vary greatly but it is a matter of estimating the time it will require in order for the land to be fully utilized for growing crops again after construction or maintenance, and paying for the loss resulting during that time.

Problems do arise concerning claims from individuals or corporation with a limited or restricted right to use the land. Such rights as granted hunters do not give the holder exclusive right to the land and thereby these rights are subject to further alienation by the Owner, Crown and/or tenant. For that reason no action may be sustained against the Company by holders of such rights as long as the pipeline construction conforms to the specifications of the government agency under whose jurisdiction the pipeline was constructed.

THE SUPERVISOR, LAND AND RIGHT-OF-WAY DEPARTMENT IS RESPONSIBLE FOR INTERPRETATION AND REVISION OF THIS PROCEDURE.

WESTCOAST TRANSMISSION COMPANY LIMITED **PIPELINE OPERATION AND MAINTENANCE MANUAL**	REFERENCE No 5.2 EFFECTIVE DATE July 31, 1981
SUBJECT: PROCEDURE FOR RIGHTS-OF-WAY ACQUISITION, USE OF ESTABLISHED RIGHTS-OF-WAY AND SETTLEMENT OF DAMAGE CLAIMS	PAGE No 1 OF 4 — MANAGEMENT APPROVED SUPERSEDES October 11, 1980

SCOPE: Covers the procedure for rights-of-way acquisition, use of established rights-of-way and settlement of damage claims.

PURPOSE: To provide operation and maintenance personnel with specific requirements related to rights-of-way acquisition, use of established rights-of-way and settlement of damage claims.

1. GENERAL

The rights to occupy certain lands by the pipeline are granted to Westcoast Transmission Company by a Grant of Right-Of-Way which gives the Company the right to construct, operate, maintain, inspect, patrol, alter, remove, replace, reconstruct and repair one or more pipelines and the right of ingress and egress to and from the right-of-way. When these rights are exercised Westcoast shall compensate the land Owner and/or tenant for damages done to any buildings, crops, pasture, fences, drains, timber, livestock or other improvements.

2. PRIVATE LANDS

To preserve and foster good public relations, Westcoast personnel are required to notify the land Owner and/or tenant prior to entering or his land when construction or routine maintenance is required. This notice can be given by Westcoast operation and maintenance personnel or by the Lands and Right-Of-Way Department if the work to be undertaken is of a minor nature. If major work is contemplated and extensive damage will be done to the property, the Lands and Right-Of-Way Department shall be notified and a representative will make prior arrangements with the land Owner and/or tenant. Should an emergency maintenance problem arise and it is not convenient to notify the property Owner and/or tenant the maintenance crew may enter the property at its discretion. However, the Lands and Right-Of-Way Department shall be notified immediately. A representative will then contact the appropriate land Owner, Owners or tenants.

Ingress and egress shall be by such routes as mutually agreeable by the land Owner and/or tenant and maintenance personnel. Minimizing damages and land Owner and/or tenant inconvenience shall be considered paramount.

Upon completion of the work the Lands and Right-Of-Way Department shall be notified and a representative will call on the land Owner and/or tenant to arrange compensation for damages and to obtain a damage release.

3. CROWN LANDS

If maintenance work is confined to Westcoast's right-of-way and ingress and egress is by existing roads and trails, notification is not required. However, the Lands and Right-Of-Way Department shall be notified.

If damages are anticipated off right-of-way during routine maintenance, prior notice will be given to Lands and Right-Of-Way Department who will make the necessary arrangements with the appropriate government agency. In an emergency prior notice is not required but the Lands and Right-Of-Way Department shall be notified as soon as possible and contact will be made to the appropriate government agency. Upon completion of the work the Lands and Right-Of-Way Department shall be notified and will settle the damages which have occurred.

4. RIVERS, STREAMS, WATERWAYS, ROADS, RAILROADS, ETC.

Prior to commencing routine maintenance, and particularly new construction, the Lands and Right-Of-Way Department shall be notified. The Lands Department will advise the operation and maintenance personnel the local agency to contact. If the appropriate agency or land Owner is not available locally the Lands and Right-Of-Way Department will make the necessary arrangements. In an emergency, notice is not required. The Lands and Right-Of-Way Department shall, however, be notified as soon as possible, and will then contact the appropriate agency or Land Owner.

WESTCOAST TRANSMISSION COMPANY LIMITED

PIPELINE OPERATION AND MAINTENANCE MANUAL

REFERENCE NO. 5.2

EFFECTIVE DATE July 31, 1981

PAGE No 4 OF 4

MANAGEMENT APPROVED

SUPERSEDES October 11, 1980

SUBJECT: PROCEDURE FOR RIGHTS-OF-WAY ACQUISITION, USE OF ESTABLISHED RIGHTS-OF-WAY AND SETTLEMENT OF DAMAGE CLAIMS

Upon completion of the work any required releases shall be obtained from the appropriate agencies, Owner and/or tenants by a Lands and Right-Of-Way Department representative.

THE SUPERVISOR, LANDS AND RIGHT-OF-WAY DEPARTMENT IS RESPONSIBLE FOR INTERPRETATION AND REVISION OF THIS PROCEDURE.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Appendix 2d

Inland Natural Gas Co. Ltd.

ING137 (REV. 1980)

LAND TITLE ACT

FORM 17

(Sections 151, 152 (1), 220)

APPLICATION

NOTE: Before submitting this application for interests under (1) and (2), applicants should check and satisfy themselves as to the tax position, including taxes of the Crown provincial, a municipality, and improvement, water and irrigation districts.

NATURE OF INTEREST **CHARGE**	**TRUE VALUE** ________________
	STATUTORY RIGHT-OF-WAY Nature of Charge

HEREWITH FEE OF $

Full Name, Address, Telephone Number of person presenting application

LEONARD WILLOUGHBY SNOWSELL
INLAND NATURAL GAS CO. LTD.
BOX 12503, 1066 WEST HASTINGS ST.
VANCOUVER, BRITISH COLUMBIA V6E 3G3
684-0404

____
Signature of Authorized Agent

INLAND NATURAL GAS CO. LTD.
GRANT OF EASEMENT AND STATUTORY RIGHT-OF-WAY

WHEREAS the Grantor

of the in the

is the registered owner or entitled to become the registered owner of that certain parcel or tract of land situated in the Province of British Columbia, and more particularly known and described as:

(hereinafter referred to as the "Lands of Grantor")

AND WHEREAS it is necessary for the operation and maintenance of the undertaking of INLAND NATURAL GAS CO. LTD. a Company duly incorporated (Incorporation No. 20737) under the laws of the Province of British Columbia, having its registered office at Box 12503, 1066 West Hastings Street, in the City of Vancouver, in the Province of British Columbia being a corporation authorized to transport oil or gas or solids as defined in the Pipe-lines Act, (hereinafter referred to as the "Grantee") to obtain a STATUTORY RIGHT-OF-WAY through, under and across the said lands;

AND WHEREAS the Grantor has agreed to grant to the Grantee a STATUTORY RIGHT-OF-WAY in the manner hereinafter more particularly expressed;

NOW THEREFORE in consideration of the sum of Dollars ($) of lawful money of Canada now paid to the Grantor by the Grantee, the receipt of which is hereby acknowledged, the Grantor does hereby grant, convey and transfer unto Grantee, its successors and assigns, the exclusive right, license, liberty, privilege and easement by way of right-of-way on, over, under and through the said Lands of Grantor, to lay down, construct, operate, maintain, inspect, patrol (including aerial patrol), alter, remove, replace, reconstruct and repair one or more pipelines together with all the works of the Grantee useful in connection with or incidental to its undertaking including but without limiting the generality of the foregoing, all such drips, valves, fittings, meters and other equipment and appurtenances, whether or not similar to the foregoing, as may be useful or convenient in connection therewith or incidental thereto for the carriage, conveyance and transportation of natural and artificial gas and other gaseous or liquid hydrocarbons and any products or by-products thereof.

Grantor and Grantee agree that as soon as Grantee shall have laid down the initial pipe in the exercise of the foregoing authority, the right, licence, liberty, privilege and easement hereby granted, except as hereinafter otherwise specified, shall thereupon and thereafter be confined and restricted to the following portion of the Lands of Grantor (herein called the "Statutory Right-of-Way"):

A strip of land not more than   feet in perpendicular width lying between lines parallel to and distant such number of feet as may be designated by the Grantee from each side of the surveyed line and surveyed line produced of the initial pipe-line, as located by the Grantee in connection with its undertaking, and shown in the survey referred to in paragraph FIRST hereof.

Grantee shall have and is hereby given the right to use such of the Lands of Grantor immediately adjacent to either side of the said Statutory Right-of-Way as may reasonably be required by the Grantee in connection with the construction, repair or replacement of the pipelines and works of the Grantee, and for ingress to and egress from the said Statutory Right-of-Way for its servants, agents, contractors and subcontractors with vehicles, supplies and equipment for all purposes useful or convenient in connection with or incidental to the exercise and enjoyment of the rights and privileges herein granted for so long as the Grantee desires to exercise the same.

All of the said rights, liberties and easements are hereby granted on the following terms and conditions which are hereby covenanted and agreed to by and between the Grantor and the Grantee.

FIRST: The Grantor and the Grantee mutually agree that when and so soon as the Grantee shall deposit a Statutory Right-of-Way plan based upon a survey in accordance with the requirements of the Land Title Act and regulations of the Surveyor General in the proper Land Title Office, such plan and the survey upon which it is based defining the Statutory Right-of-Way hereinabove referred to shall in all respects thereafter establish, govern and define the Statutory Right-of-Way, and the remaining Lands of the Grantor shall, but only to the extent aforesaid, thereupon be released and discharged from the right, liberty and easement by way of the right-of-way hereby granted.

The Registrar is authorized to make such entries in the register as may be necessary to give effect to the foregoing.

The Grantor further agrees to accept the accuracy of the said survey and the Statutory Right-of-Way plan so deposited without examination or further approval and authorizes the Registrar to accept the plan for deposit without his signature thereon.

SECOND: The Grantee covenants with the Grantor that it will deposit a Statutory Right-of-Way Plan as provided for in paragraph FIRST hereof, on or before the expiration of three years after the Grantee shall have laid down the initial pipe in exercise of the foregoing right, liberty and easement by way of right-of-way hereby granted.

THIRD: The Grantor shall not, without the prior written consent of the Grantee, excavate, drill, install, erect, construct or permit to be excavated, drilled, installed, erected or constructed on or under the said Statutory Right-of-Way any pit, well, foundation, pavement, building or other structure or installation, but otherwise the Grantor shall have the right fully to use and enjoy the said Statutory Right-of-Way subject always to and so as not to interfere with the easements, rights and privileges hereby granted and conferred upon the Grantee.

FOURTH: The Grantee shall compensate the Grantor for damage done to any buildings, crops, fences, timber and livestock on the Lands of the Grantor by reason of the exercise of the rights hereby granted.

FIFTH: The Grantee (insofar as is practicable to do so) shall bury all pipe and other installations so as not to interfere unreasonably with the ordinary cultivation of the said Statutory Right-of-Way provided however, that the Grantor shall not, without written consent of the Grantee, remove any ground cover or otherwise change the grade of any ground cover over any pipe or other installation of the Grantee.

SIXTH: Notwithstanding any rule of law or equity, the pipe (which term shall include all pipe lines, drips, valves, fittings, connections, meters and all other equipment and appurtenances brought on to, and/or erected upon or buried in or under said Statutory Right-of-Way by the Grantee) shall at all times remain the property of the Grantee notwithstanding that the same be annexed or affixed to the freehold and shall at any time and from time to time be removable in whole or in part by the Grantee, its successors and assigns.

SEVENTH: In the event the Grantee abandons the pipe-line or pipe-lines, the Grantee may, if it so elects, leave the pipe or any part thereof in place.

EIGHTH: The Grantee performing and observing the covenants and conditions on its part to be performed and observed, shall and may peaceably hold and enjoy the rights, liberties, and easements hereby granted without hindrance, molestation or interruption on the part of the Grantor or of any person claiming by, through, under or in trust for, the Grantor.

NINTH: All notices to be given hereunder may be given by registered letter addressed to the Grantee at 1066 West Hastings Street, Vancouver, B.C., and to the Grantor at   or such other address as the Grantor and the Grantee may respectively from time to time designate in writing, and any such notice shall be deemed to have been given to and received by the addressee three (3) days after the mailing thereof, postage prepaid and registered.

TENTH: Neither this Instrument nor anything herein contained shall affect or prejudice the Grantee's statutory rights, present or future, to acquire the said Statutory Right-of-Way or any other portion or portions of the Lands of Grantor under the provisions of the Pipe Lines Act of British Columbia or any other laws, which rights the Grantee may exercise in its discretion.

ELEVENTH: Nothing herein contained shall be deemed to vest in the Grantee any title to mines, ores, metals, coal, slate, oil, gas or other minerals in or under the lands comprising the said Statutory Right-of-Way, except only the parts thereof that are necessary to be dug, carried away or used in the construction of the works of the Grantee.

TWELFTH: If at the date hereof the Grantor is not the sole owner of the Lands of Grantor, this Instrument shall nevertheless bind the Grantor to the full extent of his interest therein, and if he shall later acquire a greater or the entire interest, this Instrument shall likewise extend to such after-acquired interest.

THIRTEENTH: The rights, liberties, privileges and easements hereby granted are and shall be of the same force and effect to all intents and purposes as a covenant running with the land and this Instrument, including all the covenants and conditions herein contained, shall extend to, be binding upon and enure to the benefit of the heirs, executors, administrators, successors-in-title and assigns of the parties hereto respectively.

IN WITNESS WHEREOF the Grantor has hereunto set his hand and the Grantee has caused these presents to be executed by its duly authorized Attorney in that behalf this day of , 19

SIGNED IN THE PRESENCE OF:

Signature: ....

Address: ....

....

Occupation: ....

.... Grantor

.... Grantor

.... Grantor

SIGNED IN THE PRESENCE OF:

Signature: ....

Address: ....

....

Occupation: ....

INLAND NATURAL GAS CO. LTD

Grantee

Per ....

Attorney

Memorandum as to Encumbrances, Liens and Interests

CONSENT

I, the undersigned, being the holder of a charge or encumbrance or entitled to a lien or interest referred to in the memorandum above written, for valuable consideration, hereby consent to the granting of the within easement and Statutory Right-of-Way and agree that the same shall be binding upon and take priority over my interests in or charge upon the said Lands of Grantor.

SIGNED IN THE PRESENCE OF:

....

....

....

....

Appendix 3

B.C. Hydro Construction Information

Contents:

3a Pipeline Construction

3b Standard Transmission Tower Drawings and Right-of-Way Requirements

PIPELINE CONSTRUCTION

Natural gas pipelines serve people, so they must be built into areas where people live and work. Urbanization of the country, especially expansion of the suburbs, means that pipeline owners deal with many people to minimize interference with their activities.

While construction operations provide most of the visible dramatic action, they are only the finish to a lot of planning, designing, engineering, purchasing, and scheduling activities.

This brochure describes how B.C. Hydro natural gas pipelines are planned and constructed.

Under these fields and stream in the Fraser Valley runs a B.C. Hydro natural gas pipeline

B.C. HYDRO — GAS GROUP

Introduction

B.C. Hydro purchases gas brought from northern British Columbia by Westcoast Transmission Company and carries that gas, by way of our own transmission pipelines and trunk and distribution mains, to the customer. As new homes and businesses are built, and as existing ones switch to natural gas, the capacity of this pipeline system must be expanded to meet growing demands.

Inevitably, the expansion of this natural gas pipeline system, just like the expansion of any other underground utility system, involves some disruption of peoples lives and activities. The problem of carrying out construction to provide services without disrupting farmland, natural areas, streams, residential properties, streets, and other land uses is faced by all utilities. The steps to keep this disruption to a minimum form a big part of the planning and construction of a B.C. Hydro natural gas pipeline.

Surface activity undisturbed by pipeline

Planning

B.C. Hydro tries to anticipate as far ahead as possible the likely demand for gas in a given area. Once the need is established, project planning begins.

Naturally the engineering and economic aspects of the pipeline have to be carefully planned, but it is the integration of these aspects with the effect on people and the environment to insure a minimum amount of interference that we are mostly talking about here.

The first step is the selection of the route. Sometimes this will involve the use of an existing right-of-way, sometimes a selection of a new one, often a combination of both. During the twenty or more years that might elapse between the initial installation of a pipeline and the need to expand pipeline capacity, the use of the land where the pipeline is located may have changed dramatically. The right-of-way that ran through farmland twenty years ago may now run through a suburban subdivision.

Involved in the route selection process are B.C. Hydro, government agencies, public interest groups, and potentially affected land owners. The planning process is flexible enough to reflect local needs and problems.

Studies are done to find out what the likely affects of a proposed pipeline right-of-way would be on other interests such as private property, agriculture, fisheries, recreation and wildlife. As early as possible these likely effects are discussed with engineering planners and changes can often be made to completely avoid areas where the construction would have unreasonable adverse affects on other people's interests.

The next step is to look at the problem areas. What steps can be taken to minimize the adverse affects of pipeline construction? Could the timing of the project resolve the problems? Can we make changes in traditional construction methods that will lessen the effects of construction on the right-of-way area?

Finally, we are left with a "best possible choice" and a number of effects on the right-of-way that cannot be avoided. At that point, necessary agreements to purchase the rights to lay the pipeline have to be negotiated and compensation agreements for crop damage and other unavoidable damage worked out.

The various steps that have to be taken during construction to avoid or reduce the effects on other interests are clearly detailed in the construction contract. This contract includes a detailed list dealing with the various properties and features to be encountered along the right-of-way, outlines particular problems that might be encountered, and prescribes the steps that have to be taken by the construction contractor to deal with these problems. Equally important, provision is made for adequate supervision and inspection to ensure that the contract requirements are met.

To summarize then, every effort is made during the planning process to:

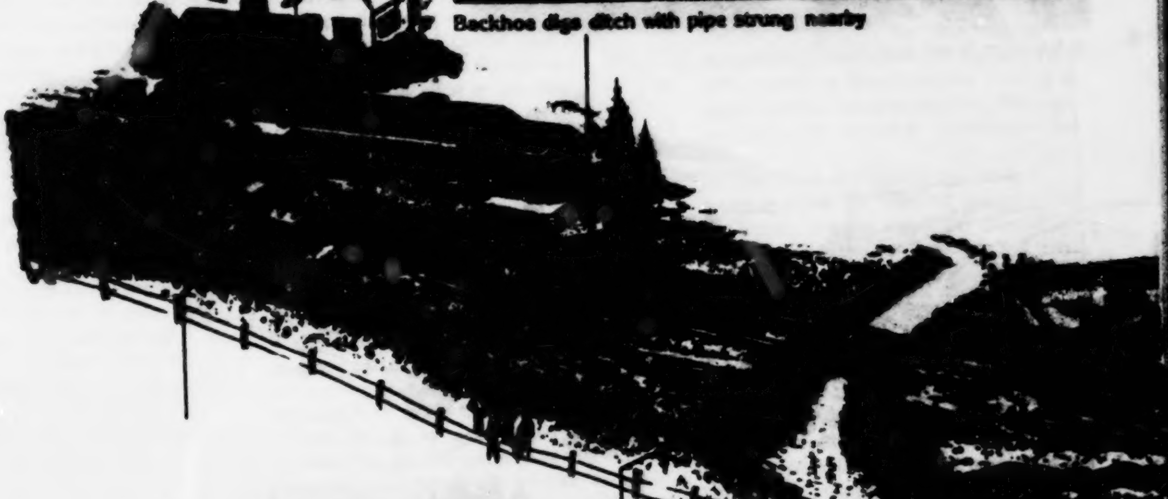
- *identify potential problems*
- *avoid those problems that can reasonably be avoided*
- *mitigate those that cannot be avoided*
- *incorporate specifications in the construction schedule and construction contract to reduce adverse effects of construction*
- *determine the steps that are needed to restore the right-of-way to its original condition as far as is reasonably practical*

Snow fencing protects children from construction

PIPELINE SPREAD IN A

Right-of-way near homes

Backhoe digs ditch with pipe strung nearby



Clearing and grading of right-of-way

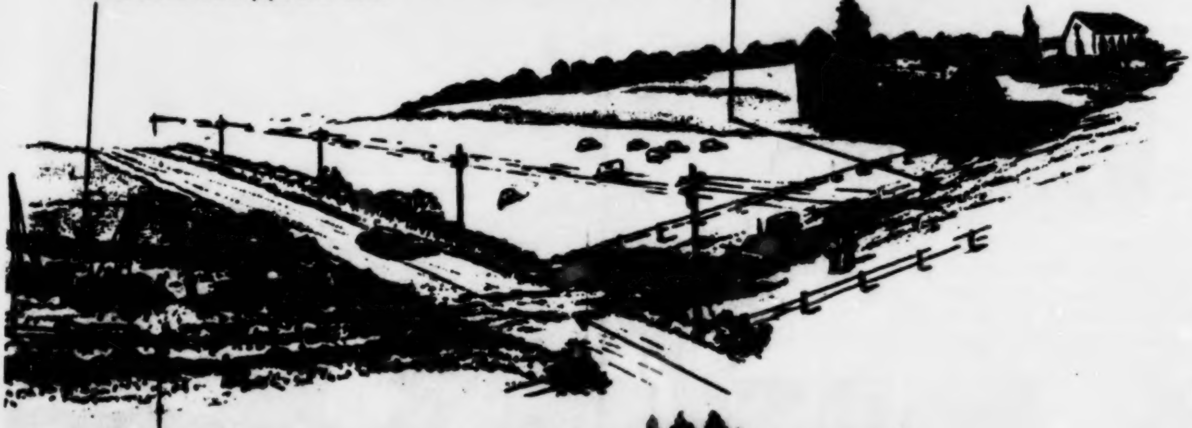
Culvert protects stream at crossing

Lowering-in crew at work

CTION

Sidebooms lower pipe into ditch

Right-of-way restoration complete



Two welders running the stringer bead

Traffic uninterrupted at bored road crossing

TURN THE PAGE FOR A DESCRIPTION OF PIPELINE CONSTRUCTION ▶

Construction

The pipeline construction unit is known as a 'spread'. Each spread is organized and equipped as a self-contained unit capable of moving across country, clearing its way, constructing and testing the pipeline, and restoring the ground surface for normal use. The number of spreads needed depends upon the size and length of the pipeline and the time available for its construction. A spread is necessarily strung out for a considerable distance along the right-of-way. The advance units may be 15 to 20 kilometers ahead of the finishing units and the overall construction rate is governed by the rate of the slowest operation.

The Right-Of-Way

The 'right-of-way' is a clearly identifiable strip of land along which the pipeline is installed. Surveyors work along this right-of-way during the final stages of the planning process to determine the exact location of the pipe and the amount of clearing that is required to enable the construction equipment to operate.

Generally, the objective is to have the affected area as narrow as practical. However, because of the size of construction equipment, additional working space outside the right-of-way is often required. For example, at a stream crossing additional space may be required to ensure that material dredged from the pipeline trench can be piled in such a manner that silt is not washed back into the stream. In other areas, to avoid some particular feature — a house or a grove of trees — the allowable working space outside the right-of-way is smaller than ideal for construction purposes.

Clearing & Grading

The term 'clearing' includes removal of above-ground obstacles to work such as trees, brush, crops, and boulders. It also includes removal of tree stumps and roots in the ditch line. The term 'grading' means levelling the ground surface as needed to provide transit and operation of vehicles and equipment, and to permit placement of the pipeline at the desired elevation. This involves cutting away the earth in some places and building it up in others.

Ditching

The next stage is the digging of a ditch in which the pipe is to be laid. The ditch has to be deep enough to ensure that the pipe cannot affect or be affected by normal surface activity. Usually this means a minimum of four feet of cover over the top of the pipe.

Hay bales remove siltation in stream

The trench must be wide enough to permit the pipe to be lowered in without damage to the pipe or its protective coating. In swampy areas concrete weights are placed on the pipe to hold it in position and the trench must be wide enough to accommodate these where necessary.

Topsoil is removed in the trenching area and stockpiled. Under ideal dry working conditions the trench is excavated by backhoe or ditching machine and the excavated material banked along the trench. After the pipe is laid, the subsurface material is replaced first and the topsoil restored to its original position.

In wet areas, drag-lines or clamshells are used to excavate wet material. This material is stockpiled in such a way as to prevent silt from running into streams. Water accumulating in the trench is pumped out in such a manner as to avoid silt running into watercourses or other sensitive land areas. In some areas, a process known as 'well-pointing' is used to lower the ground-water level to avoid problems associated with working in wet soil conditions.

At stream crossings, particular attention is paid to avoid stream disturbance and siltation that could have an adverse effect on aquatic life. Construction scheduling can solve many of the problems associated with fisheries by undertaking construction at a time when the fewest number of fish are in the stream. If necessary, stream crossings can be scheduled independently of the main construction project.

Particular care is taken at all stream crossings to ensure that stockpiled material cannot easily enter the stream during ditching. When necessary, unstable wet material is trucked away from the site, and the ditch is backfilled with stable material.

Guidelines prepared by the Federal Fisheries Service are followed during stream crossings and site-specific advice on the implementation of these guidelines is available during the construction program from environmental advisors retained by B.C. Hydro Gas.

Pipe Laying

Prior to trenching, the pipe is hauled to the right-of-way and strung out where it is to be installed. Depending upon the particular conditions for each construction project, the pipe may be given a protective coating at the factory. In other instances, this protective coating is applied at the construction site. The pipe is bent on site to suit the contours of the land.

Sections of the pipe are welded together at the site ready for lowering into the trench, and the welds are checked by x-ray. Large side-boom tractors are used for the 'lowering-in' operation. The length of the individual sections lowered in depends on the particular site conditions. Where necessary, pipe can be lowered into the trench and then moved under existing utility lines, or under a stream temporarily by-passed through a culvert.

Concrete weights to prevent the pipeline from floating to the surface in wet terrain are installed after the pipe is in the trench.

Once the sections of pipe are in the trench, each new section is 'tied in' to the balance of the pipeline by welding each new section of pipe to existing pipe.

Backfill

Immediately after the lowering-in and tie-in, the excavated material is replaced in the trench. Topsoil that has been separated during the digging of the trench is replaced last, and the construction equipment proceeds down the line.

Cleanup & Restoration

The right-of-way is cleaned up by the removal and disposal of construction debris and surplus material. Quite often disposal of debris can be helpful. Rocks and cut brush can be used as land erosion control materials. Considerable restoration of the right-of-way surface is accomplished during backfilling operations, as already mentioned.

On agricultural lands the return of permanent crops, such as soft fruit bushes, can be left to the land owner with appropriate compensation being paid.

Where movement of heavy equipment has created soil compaction problems, subsoiling or deep-plowing is done by either the contractor or, with appropriate compensation, by the land owner.

Where drain tiles, fences, or other permanent farm fixtures have been disturbed, they are returned to their original condition.

Private lawns, gardens, driveways, etc., are dealt with in a similar manner, either through direct compensation to the property owner or through the provision of landscaping services by Hydro Gas.

At all stream crossings, sites are restored to their original condition as far as is reasonably practical. This may involve the trucking in of new gravel, appropriate grading, the buildup of stream banks and, where necessary, the restoration of streamside vegetation.

Following the initial site cleanup and restoration, the right-of-way is monitored to ensure that the vegetation and restoration of the right-of-way takes place.

Testing

Once the pipeline is completed, a plug known as a 'pig' is run through the line to clean out debris.

Finally, the pipeline is pressurized with water or air to prove structural integrity. If water is used (hydrostatic testing) precautions are taken to prevent possible environmental problems that could arise from the transfer of water between watersheds.

Operation

Markers showing the exact locations of pipelines are installed at most fence crossings. These markers identify B.C. Hydro as the owner of the pipeline and natural gas as the commodity transported in it. Placement of location markers and the information provided is subject to government regulation and is intended to warn the general public of the presence of the pipeline.

This pig has traveled many kilometers

In settled areas like the Fraser Valley, the only other visible sign of the pipeline after construction is the presence of regulator stations above ground.

Once the cleanup and restoration program is completed, the right-of-way, for all practical purposes, can be returned to its original pre-construction uses.

Fraser Valley 1977

Between June and September 1977, B.C. Hydro Gas installed 30 kilometers of 42-inch diameter pipeline from Hydro's gate station at Huntingdon, near the U.S. border, to the site of a new valve station in Langley.

Throughout the project, close contact was maintained with private citizens who were affected, and municipal and other government officials. Careful public relations preparation throughout the project helped to expedite construction and there were no significant difficulties with land owners.

Impact studies for the project started in 1974 and the steps outlined in this brochure were followed in the project planning. The pipeline ran through a typical cross-section of the semi-rural lower Fraser Valley. Almost 70% of the pipeline ran through agricultural land, with another 23% running through woodlands.

Pipeline construction adjacent to subdivision

The remaining portion, about 7%, ran through residential, institutional, and commercial lands. The farmland was mostly pasture, but included soft fruits and other crops.

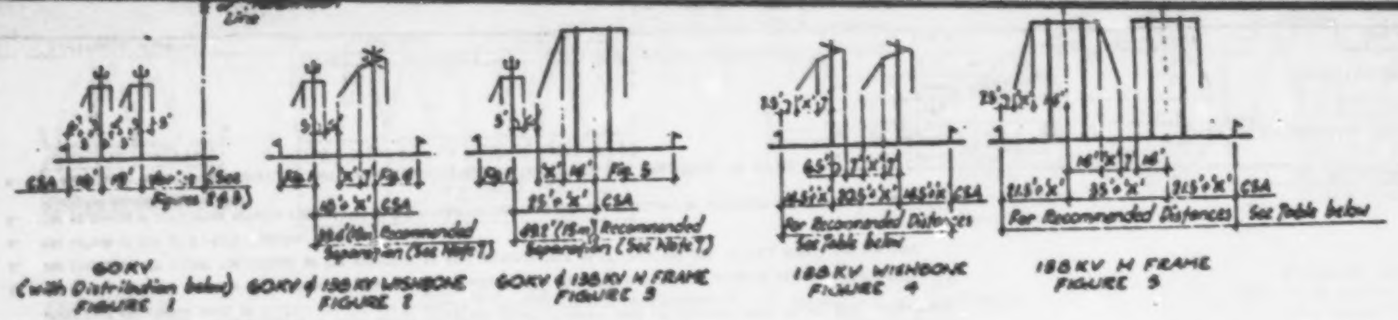
Several small streams of considerable importance to salmon and other fishes were crossed and the effects on these streams were very carefully monitored. Although there was heavy siltation at some stream crossings during construction (in some instances under controlled experimental conditions), there were no permanent adverse effects. A note of fisheries interest is the fact that the pipeline was installed alongside the newly-constructed Fraser Valley Hatchery at Abbotsford, and one of the stream crossings was carried out at the corner of the hatchery property.

Construction passed through housing subdivisions, chicken ranches, hay and corn fields, strawberry and raspberry patches, orchards, blueberry fields and a wildfowl sanctuary — all with minimal adverse effects.

This recent project provides an excellent chance for anyone interested to see the minimal adverse permanent effects of pipeline construction.

If you wish further information, please contact:

Mr. R.G. Blakely
Manager
System Design Department
B.C. Hydro & Power Authority
298-1311 (local 124)


Line
CSA
10'
13'
See Figures 2 & 3
60KV
(with Distribution below)
FIGURE 1
CSA
Fig. 5
49.2' (15m) Recommended Separation (See Note 7)
60KV & 138KV WISHBONE
FIGURE 2
95'+'X'
CSA
Fig. 5
49.2' (15m) Recommended Separation (See Note 7)
60KV & 138KV H FRAME
FIGURE 3
For Recommended Distances See Table below
CSA
138KV WISHBONE
FIGURE 4
CSA
For Recommended Distances
See Table below
138KV H FRAME
FIGURE 5

DESCRIPTION OF LINE	FIGURE NO.	SPAN LENGTH SEE NOTE 1	CSA MINIMUM REQUIREMENTS			TYPICAL B.C.H. & P.A. R/W WIDTHS		RECOMMENDED DISTANCES FEET (METRES)				REMARKS
			COND. SWING @ 100°F/-"Z"	℄ TO R/W EDGE	℄ TO ℄ SEE NOTE 2	1 STRUCTURE	2 STRUCTURES	℄ TO R/W EDGE	℄ TO ℄	TOTAL R/W WIDTHS 1 STRUCTURE	TOTAL R/W WIDTHS 2 STRUCTURES	
60 KV SINGLE CIRCUIT CONSTRUCTION WITH DISTRIBUTION BELOW -Pin-Type, 397 MCM 37/AL, 1/2+0+0"T, Max Tension 3000 lbs	1	300	5	15	12	-	-	16.4(5)	19.7(6)	-	-	SEE NOTES 3 & 4
138 KV SINGLE CIRCUIT CONSTRUCTION -Wishbone structure partridge 26/7 1/2+½+C @ 0°F Max Tension 4000 lbs.	4	530	10	24.5	30.5	60	115 TO 130	29.5(9)	42.7(13)	59.1(18)	101.7(31)	SEE NOTES 6,7 & 8
		700	16	30.0	30.5	-	-	32.8(10)	42.7(13)	65.6(20)	108.3(33)	SEE NOTE 7
- Wishbone & H Frame - Partridge 26/7 1/2+½+C @ 0°F Max Tension 4200 lbs.		700	16	27.5	54	-	-	39.4(12)	52.5(16)	78.8(24)	131.2(40)	SEE NOTE 4
- H Frame Structure - Hawk 26/7 1/2 + ½+C @ 0°F Max Tension 6000 lbs.	5	700	10.5	22	46.5	100	170	32.8(10)	52.5(16)	65.6(20)	114.8(35)	SEE NOTE 7
		1000	16.5	41	54.5	100	170	42.7(13)	55.8(17)	85.3(26)	141.1(43)	

NOTES:

1. THE TERM 'SPAN LENGTH' MEANS A LENGTH IN WHICH 90% OF THE SPANS ARE NOT EXCEEDED OVER THE PROPOSED ROUTE OF THE LINE. INDIVIDUAL SPANS THAT ARE LONGER SHALL BE CHECKED AND THE R/W INCREASED IF NECESSARY TO MEET CSA REQUIREMENTS.
2. THE ℄ TO ℄ DISTANCE IS BASED ON A CONDUCTOR SHOWN ON ONE STRUCTURE WHILE THE CONDUCTORS ON THE ADJACENT STRUCTURE ARE AT REST.
3. THE 60KV IS SHOWN ONLY FOR DETERMINING R/W WIDTHS WHEN IT IS ADJACENT TO HIGHER VOLTAGE LINES.
4. WHERE THERE IS A COMBINATION OF WISHBONE AND H FRAME CONSTRUCTION ON THE SAME CIRCUIT, THE H FRAME PHASE SPACING SHALL BE USED.
5. CSA REFERS TO CSA 22.3 - 1970 STANDARD.
6. IN HEAVILY TREED AREAS THE ℄ TO R/W EDGE DISTANCE MAY BE INCREASED TO 10 METRES TO ALLOW FOR BRUSH CONTROL WITHIN THE R/W BOUNDARY.
7. THE RECOMMENDED SEPARATION BETWEEN CIRCUITS IS GREATER THAN THE CSA VALUES SHOWN TO ALLOW FOR INCREASED PHASE SPACING, [illegible] CLEARANCE AND HOT LINE MAINTENANCE REQUIREMENTS AT ANGLE STRUCTURES.
8. THE RECOMMENDED ℄ TO EDGE DISTANCE IS GREATER THAN THE CSA VALUES SHOWN TO ALLOW FOR INCREASED PHASE SPACING AT DEAD-END STRUCTURES.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

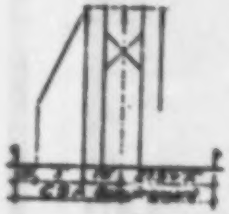
GENERAL RIGHT OF WAY WIDTHS
FOR
138KV AC TRANSMISSION LINES

B - 707 - 234

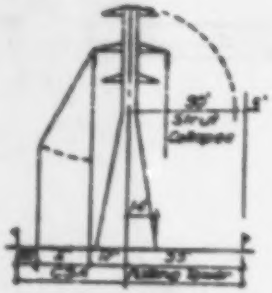
SHEET 1 OF 4

SUPERSEDES DRAWINGS

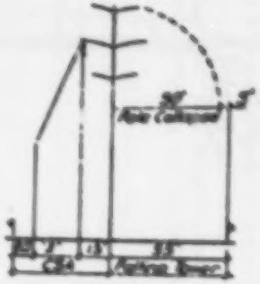
REVISIONS


C.S.A. Requirement

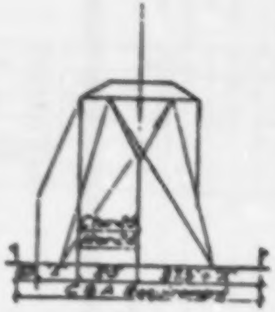
H FRAME
FIGURE 10


90°
5'
Structure Collapse
C.S.A.
Falling Tower

LATTICE STEEL
FIGURE 11


90°
5'
Pole Collapse
C.S.A.
Falling Tower

STEEL POLE
FIGURE 12


C.S.A. Requirement

GUYED 'Y'
FIGURE 13

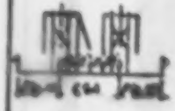


FIGURE 14

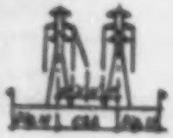


FIGURE 15

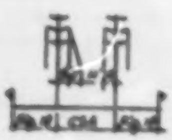


FIGURE 16

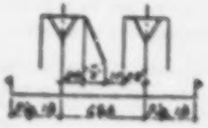


Fig.13
CSA
Fig.13

FIGURE 17

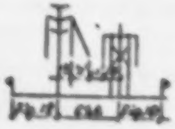


FIGURE 18

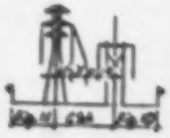


FIGURE 19

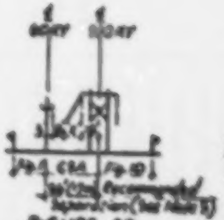

Recommended
Separation (See Note 5)
CSA

FIGURE 20

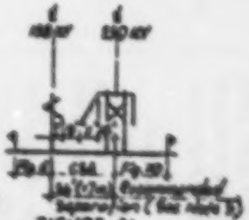

Recommended
Separation (See Note 5)
CSA

FIGURE 21

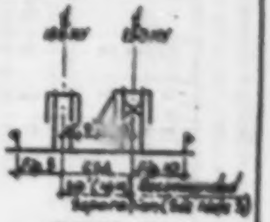

Recommended
Separation (See Note 5)
CSA

FIGURE 22

DESCRIPTION OF LINE(S)	REFERENCE FIGURE(S)	SPAN LENGTH SEE NOTE 1	CSA MINIMUM REQUIREMENTS			TYPICAL B.C.H. & P.A. R/W WIDTHS		RECOMMENDED DISTANCES FEET (METRES)				REMARKS
			COND. SWING [illegible]	℄ TO R/W EDGE	℄ TO ℄ SEE NOTE 2	1 STRUCTURE	2 STRUCTURES	℄ TO R/W EDGE	℄ TO ℄	TOTAL R/W WIDTHS		
										1 STRUCTURE	2 STRUCTURES	
H Frame Structure - [illegible]	10 & 14	[illegible] 1000	15 21.5	42.5 50	52 60.5	125	210	42.7 (13) 49.2 (15)	52.7 (16) 60.9 (19)	[illegible] [illegible]	[illegible] 167.3 (51)	SEE NOTE 6
Guyed Y S.C. Structure - [illegible]	13 & 17	1000	26.5	53	63.5	135	-	65.6 (20)	65.1 (20)	131.2 (40)	[illegible]	
Lattice Steel S.C. Structure - [illegible]	11 & 16	1000	22.5	50	56.5	150	-	55.0 (17) SEE NOTE 3	69.0 (21)	111.0 (34)	180.5 (55)	
Steel Pole S.C. Structure - [illegible]	12 & 15	1000	25	57.5	65.0	120	-	55.0 (17) SEE NOTE 3	66.0 (20)	111.0 (34)	177.2 (54)	
H Frame S.C. Structure & Double Circuit Lattice Steel - [illegible]	19	1000/[illegible]	21.5/25.5	50/50	60.5	-	-	55.0 (17) SEE NOTE 3	72.1 (22)	-	160.7 (49)	
H Frame S.C. Structure & Double Circuit Steel Pole - [illegible]	18	1000/1000	21.5/25	50/57.5	65	-	-	55.0 (17) SEE NOTE 3	69.0 (21)	-	160.5 (49)	

NOTES:

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

GENERAL RIGHT OF WAY ROUTING
FOR
230KV AC TRANSMISSION LINES

[illegible] 1977

C

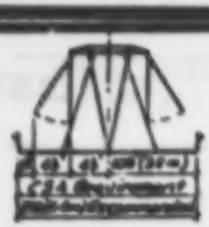

C.S.A. Requirement

FIGURE 23
1-500 KV Circuit
(See Notes 1, 2 & 3)

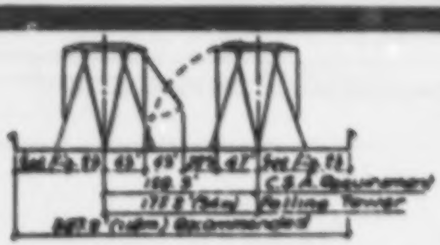

43'
43'
C.S.A. Requirement
Falling Tower
Recommended

FIGURE 24
2-500 KV Circuits
(See Notes 1 & 4)

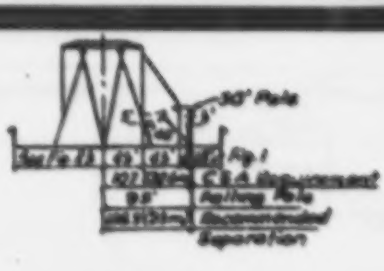

30' Pole
Fig. 1
C.S.A. Requirement
95'
Falling Pole
Recommended
Separation

FIGURE 25
500KV & 60 KV Pin
(See Note 5)

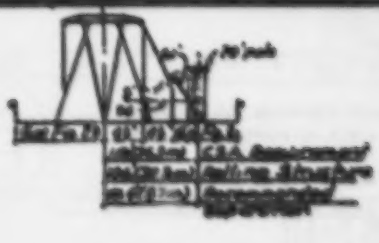

70' pole
C.S.A. Requirement
Falling Structure
Recommended
Separation

FIGURE 26
500 KV & 138 KV H-Frame
(See Note 5)

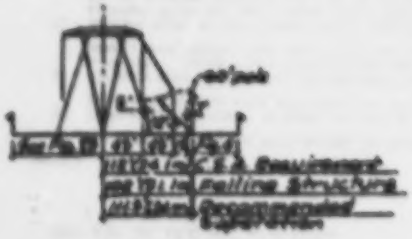

60' pole
C.S.A. Requirement
Falling Structure
Recommended
Separation

FIGURE 27
500 KV & 138 KV Wishbone
(See Notes 5 & 6)

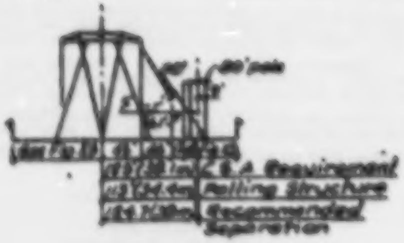

80' pole
C.S.A. Requirement
Falling Structure
Recommended
Separation

FIGURE 28
500 KV & 230KV H-Frame
(See Note 5)

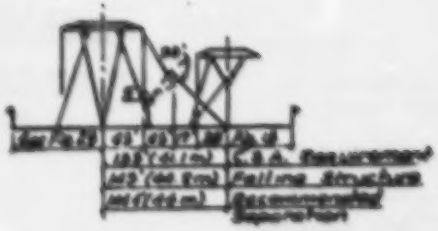

C.S.A. Requirement
Falling Structure
Recommended
Separation

FIGURE 29
500 KV & 230 KV "Y" Guyed
(See Note 5)

NOTES:

1. THE RECOMMENDED R/W WIDTHS ALSO APPLY TO 500KV MICA AND PEACE RIGID TYPE TOWERS.
2. THE 500KV CONDUCTOR SWING DIMENSION ASSUMES A SPAN OF 1930 FEET USING "MICA" 667 MCM CONDUCTOR AND 1790 FEET USING "PEACE" 628 MCM CONDUCTOR. THESE ARE LENGTHS IN WHICH APPROXIMATELY 95% OF THE SPANS ARE NOT EXCEEDED AND ARE DERIVED FROM SPAN LENGTH STUDIES ON THE EXISTING MICA AND PEACE CIRCUITS. INDIVIDUAL SPANS THAT ARE LONGER SHALL BE CHECKED AND THE R/W INCREASED IF NECESSARY TO MEET CSA REQUIREMENTS.
3. THE PHASE SPACING OF THE MICA AND PEACE TOWERS VARIES; 45 FEET APPROXIMATES THE MAXIMUM.
4. THE SEPARATION SHOWN FOR FALLING TOWER CLEARANCE BETWEEN 500KV CIRCUITS PROVIDES CLEARANCE BETWEEN A FALLING TOWER AND THE CONDUCTOR OF AN ADJACENT CIRCUIT FOR 95% OR MORE OF ALL 500KV TOWER TYPES AND HEIGHTS, BASED ON STUDIES OF EXISTING LINES. THE STUDY ASSUMES THAT A GUYED TOWER WILL PIVOT ABOUT THE BASE AND A RIGID TOWER ABOUT THE LEGS FARTHEST AWAY FROM THE ADJACENT CIRCUIT. THE SEPARATION SHOWN (56m) IN FIG. 24 IS RECOMMENDED FOR PEACE & MICA TOWERS. WHERE PEACE TOWERS ARE USED IN AREAS KNOWN TO BE RELATIVELY FLAT AND LOCATED ADJACENT TO ONE ANOTHER, THE SEPARATION MAY BE REDUCED TO 160.0 FT. (49m).
5. THE SEPARATION BETWEEN 500KV AND LOWER VOLTAGE LINES (FIGS. 25 TO 29) ASSUMES THE LOWER VOLTAGE STRUCTURES COULD FALL INTO THE 500KV CIRCUIT. THE 230KV STRUCTURE HEIGHT SHOWN IS BASED ON STUDIES OF EXISTING LINES AND IS THE HEIGHT AT WHICH 95% OF THE STRUCTURES ARE NOT EXCEEDED. THE POLE HEIGHTS SHOWN FOR THE 138KV AND 60KV LINES ARE ESTIMATED.
6. WHERE H FRAME CONSTRUCTION IS USED IN CONJUNCTION WITH WISHBONE CONSTRUCTION, THE SEPARATION SHALL BE AS SHOWN IN FIG. 26.
7. CSA REQUIREMENTS REFER TO CSA 22.3 - 1976 STANDARD.
8. 60KV AND 138KV LINES SHALL NOT BE BUILT ADJACENT TO 500KV UNTIL THE INVESTIGATION ON THE EFFECTS OF INDUCED VOLTAGE IS COMPLETED.

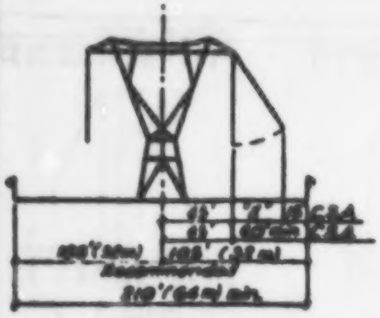
REVISIONS

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
GENERAL RIGHT OF WAY WIDTHS
FOR
500KV AC TRANSMISSION LINES
PROVIDING FALLING TOWER CLEARANCE
BETWEEN LINES

A. Cooper

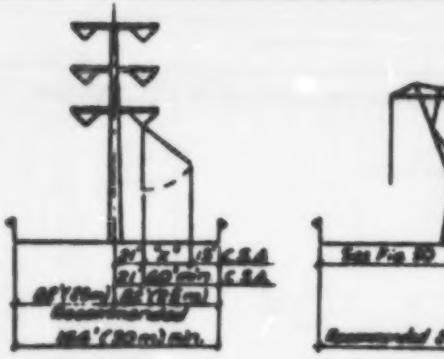
B - 727 - 834

SHEET 3 OF 4



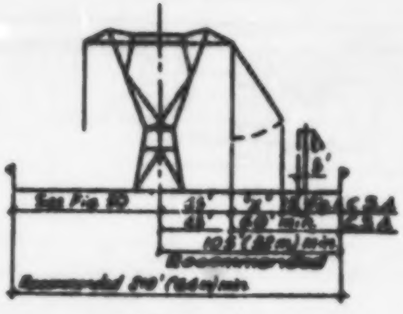
C.S.A.
C.S.A.
"X"
108' (33m)
Recommended
210' (64m) min.

FIGURE 30
1-500KV Single Circuit
(See Notes 1, 5 & 6)



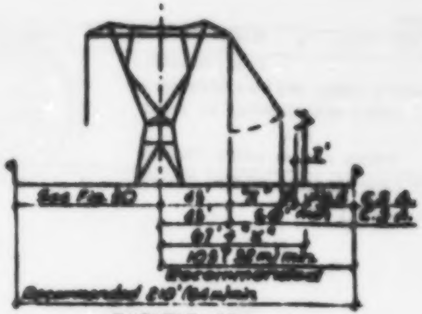
"X"
C.S.A.
C.S.A.
Recommended
164' (50m) min.

FIGURE 31
1-500KV Double Circuit
(See Notes 5 & 6)



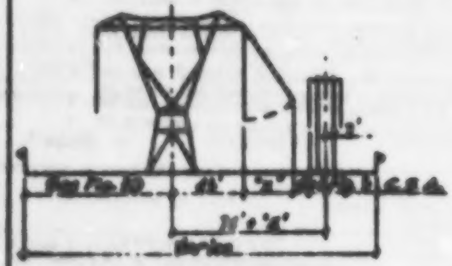
See Fig. 30
C.S.A.
C.S.A.
"X"
60' min.
103' (32m) min.
Recommended
Recommended 210' (64m) min.

FIGURE 32
500 KV & 60 KV Pin
(See Notes 1, 3 & 5)



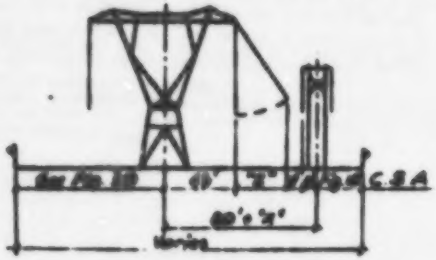
See Fig. 30
C.S.A.
C.S.A.
"X"
103' (32m) min.
Recommended
Recommended 210' (64m) min.

FIGURE 33
500 KV & 138 KV Wishbone
(See Notes 1, 3, 5 & 6)



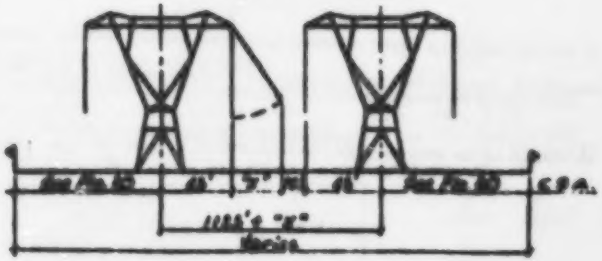
See Fig. 30
"X"
C.S.A.
Varies

FIGURE 34
500 KV & 138 KV H-Frame
(See Notes 1 & 5)



See Fig. 30
"X"
80' + "X"
C.S.A.
Varies

FIGURE 35
500 KV & 230 KV H-Frame
(See Notes 1 & 5)



See Fig. 30
"X"
See Fig. 30
C.S.A.
1185' + "X"
Varies

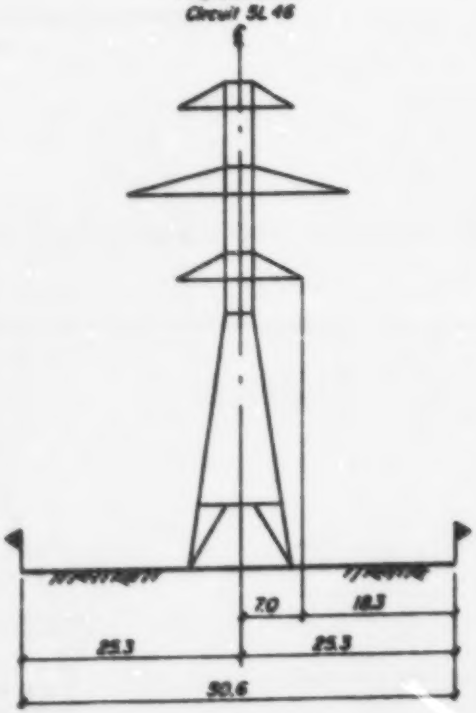
FIGURE 36
2-500 KV Single Circuit
(See Notes 1 & 5)

NOTES:

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]

GENERAL RIGHT OF WAY [illegible]
FOR
500KV AC TRANSMISSION LINES
PROVIDING CSA CLEARANCE BETWEEN LINES

SHEET 4 OF 4


Proposed 500 kV
Circuit 5L 46
℄
7.0
18.3
25.3
25.3
50.6

NOTES

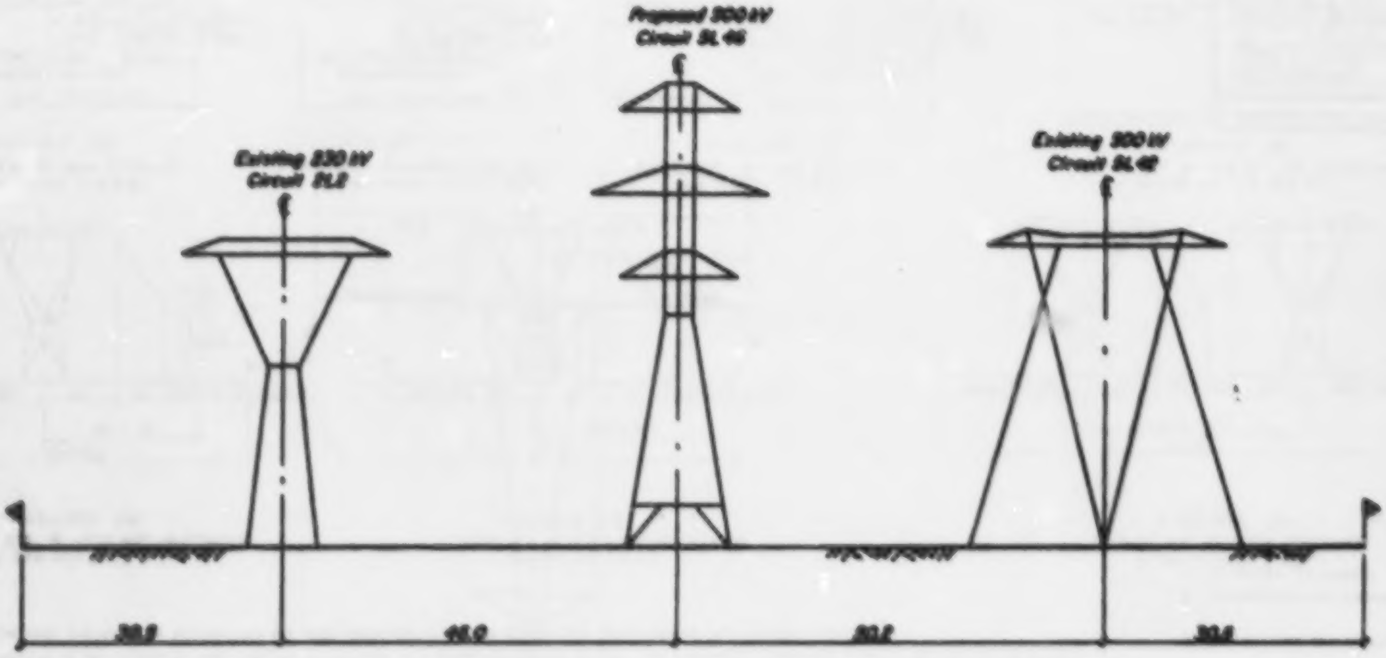
1. R/W edge distance is based on CSA Standard C22.3 No.1 - M1979 edition.
2. Dimensions are in metres.
3. Dimensions are based on Preliminary Structure Drawings.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

KELLY LAKE - CHEEKYE 500 kV
DOUBLE CIRCUIT T/L

TYPICAL RIGHT OF WAY
REQUIREMENTS SHT 1 OF 1

FIGURE 2-3


Existing 230 kV
Circuit 2L2
Proposed 500 kV
Circuit 5L46
Existing 500 kV
Circuit 5L42
30.8
46.0
50.2
30.6

NOTES:

1. Dimensions are in metres.
2. Dimensions are based on Preliminary Structure Dwgs.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

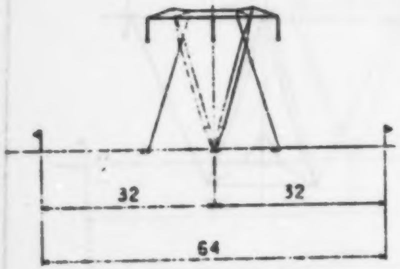
KELLY LAKE - CHEEKYE 500 kV
DOUBLE CIRCUIT T/L

TYPICAL CIRCUIT TO CIRCUIT
REQUIREMENTS SHT 2 OF 2

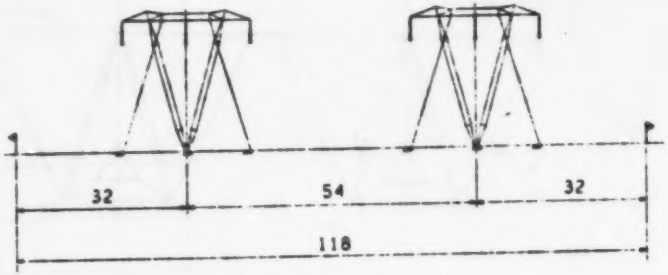
FIGURE 2-3

DWG. No

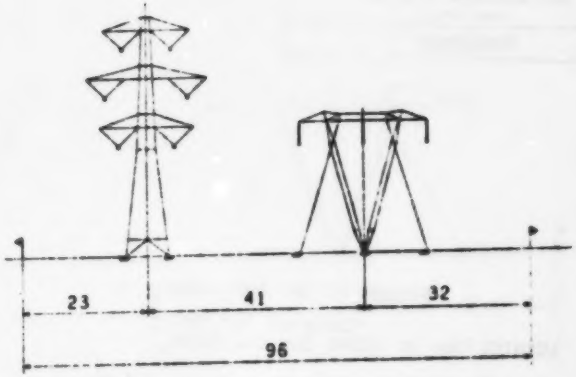
REPORT No



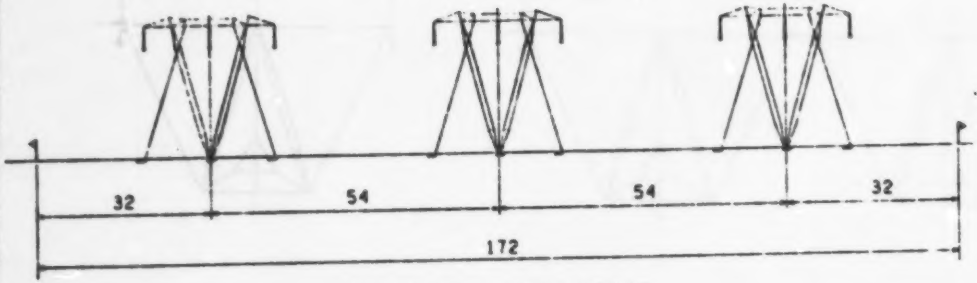
R/W FOR ONE SINGLE CIRCUIT
500 kV TRANSMISSION LINE



R/W FOR TWO SINGLE CIRCUIT
500 kV TRANSMISSION LINES



R/W FOR ONE DOUBLE CIRCUIT 500 kV TRANSMISSION LINE
AND ONE SINGLE CIRCUIT 500 kV TRANSMISSION LINE



R/W FOR THREE SINGLE CIRCUIT
500 kV TRANSMISSION LINES

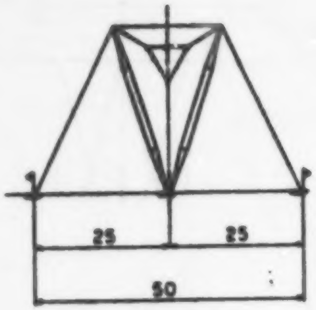
NOTES:

1. DIMENSIONS ARE BASED ON PRELIMINARY STRUCTURE DRAWINGS.
2. DIMENSIONS ARE IN METRES.

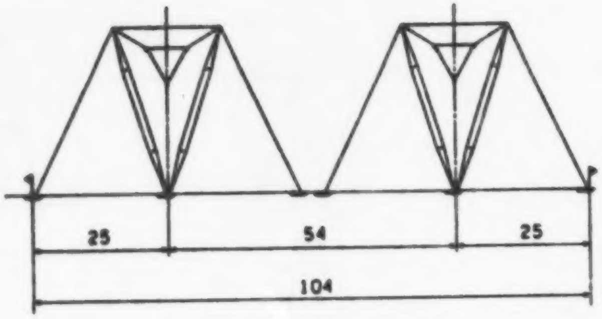
BCHydro

STIKINE-ISKUT
HIGH VOLTAGE TRANSMISSION SYSTEM
TYPICAL RIGHT-OF-WAY REQUIREMENTS
STANDARD SINGLE CIRCUIT PHASE CONFIGURATION

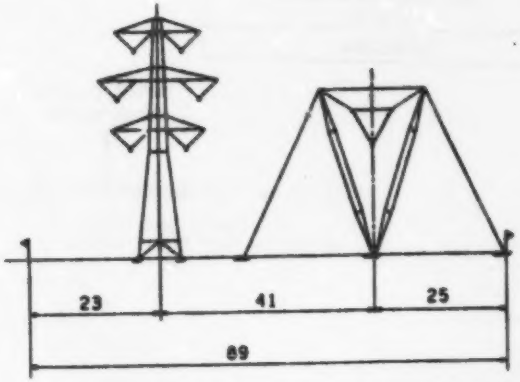
DATE	FIGURE 2-3 Sh. 1 of 3
DWN	DWG. No.



R/W FOR ONE SINGLE CIRCUIT
500 kV TRANSMISSION LINE



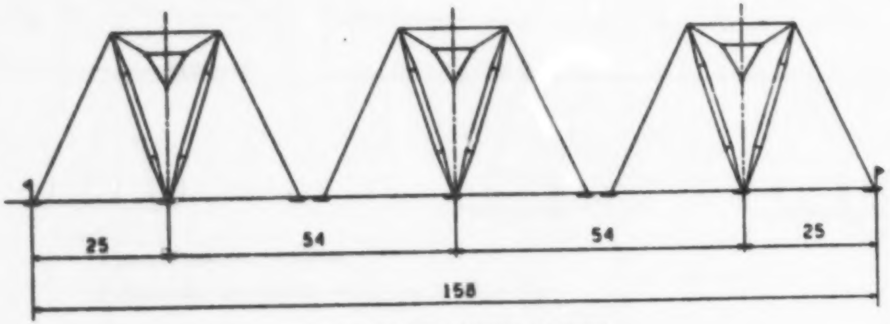
R/W FOR TWO SINGLE CIRCUIT
500 kV TRANSMISSION LINES



R/W FOR ONE DOUBLE CIRCUIT 500 kV TRANSMISSION LINE
AND ONE SINGLE CIRCUIT 500 kV TRANSMISSION LINE

NOTES:

1. DIMENSIONS ARE BASED ON PRELIMINARY STRUCTURE DRAWINGS.
2. DIMENSIONS ARE IN METRES.

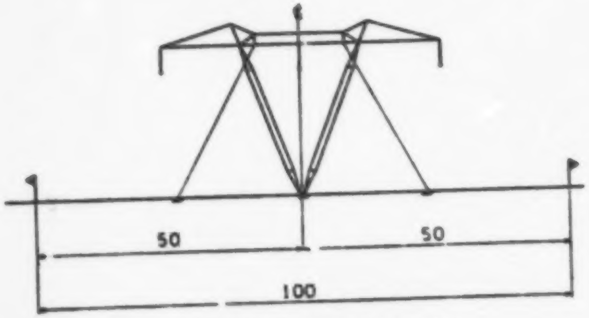


R/W FOR THREE SINGLE CIRCUIT
500 kV TRANSMISSION LINES

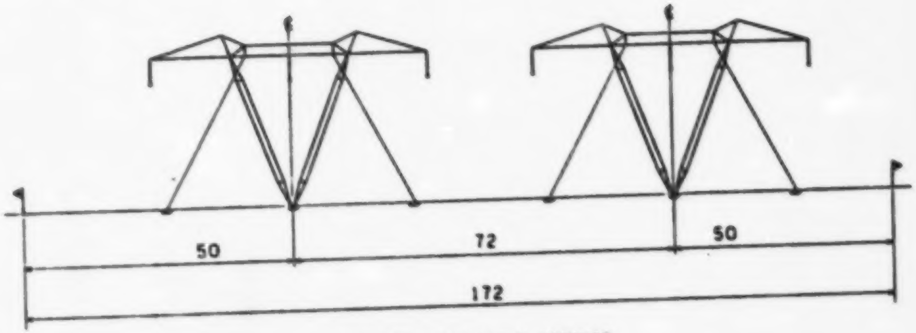
BCHydro

STIKINE-ISKUT
HIGH VOLTAGE TRANSMISSION SYSTEM
TYPICAL RIGHT-OF-WAY REQUIREMENTS
INVERTED DELTA SINGLE CIRCUIT PHASE CONFIGURATION

DATE
FIGURE 2-3 Sh. 2 of 3
DWN
DWG. No.



R/W FOR ONE SINGLE CIRCUIT
1000 kV TRANSMISSION LINE



R/W FOR TWO SINGLE CIRCUIT
1000 kV TRANSMISSION LINES

NOTES

1. DIMENSIONS ARE BASED ON PRELIMINARY STRUCTURE DRAWINGS.
2. DIMENSIONS ARE IN METRES.

BCHydro
STIKINE-ISKUT
HIGH VOLTAGE TRANSMISSION SYSTEM
TYPICAL RIGHT-OF-WAY REQUIREMENTS
STANDARD SINGLE CIRCUIT PHASE CONFIGURATION
DATE
FIGURE [illegible] Sh. [illegible] of [illegible]
DWG. No.

Appendix 4

An Annotated Bibliography,

Agricultural Implications of Linear Developments

Appendix 4a

Electrical Effects

Appendix 4 An Annotated Bibliography, Agricultural Implications of Linear Developments

This section contains an annotated bibliography on reports, booklets, and books that provide information of the opportunities and risks presented to agriculture by pipeline and electrical transmission systems. The volume of material written on this subject has mushroomed in recent years. Only those publications of which copies could be obtained are included in this bibliography. The major contributions of each of these publications are given in summaries for each item listed. The bibliography is divided into the following categories:

Section	Subject Area
4a	Electrical Effects
4b	Socio-economic Effects
4c	Land Value Effects
4d	Public Information Booklets
4e	Other Studies

Several types of publications have not been reviewed. Those not reviewed include reports such as Environmental Impact Statements that deal with specific projects and articles in the public press. Emphasis has been placed on scientific studies where original data has been generated.

Appendix 4a Electrical Effects

Author(Date): Environmental Resources Section, Dept. of Forestry, Ontario Hydro, (1978).

Title: The Effects of Extra High Voltage Transmission Lines on Laser Beam and Other Electronic Equipment used in Agricultural Operations

Publisher: Ontario Hydro

Subject: The Effects of Extra High Voltage Transmission Lines on Laser Beam and Other Electronic Equipment Used in Agricultural Operations.

Summary: A literature search and contact with manufacturers of agricultural tile laying machinery which use electronic equipment confirmed that problems have been encountered in the past when this machinery was used near EHV transmission lines. This was also partially confirmed by some of the major agricultural implement manufacturers. It was generally agreed, however, that research and new technology have alleviated many of the problems of electromagnetic charge build-up from engines and lines in newer models. To further this research, Ontario Hydro suggests the creation of a test site near an EHV transmission line where manufacturers can test their products in conjunction with Hydro engineers.

Author (date): MacLaren Plansearch Inc. (1981).

Title: Update to the Canadian Electrical Association Report 78-79 - Environmental Effects of Transmission Lines

Publisher: Canadian Electrical Association.

Subject: Electro-static and Electromagnetic Effects of High Voltage Transmission Lines on Biological Organisms.

pp.: 62

Summary: The paper is largely the work of Dr. Edwin L. Carstensen. The paper reviews and summarizes the results of scientific studies on the effects of electromagnetic fields similar to those of transmission lines on plants, animals and man. These studies are divided into the following categories:

- confirmed
- possible
- unconfirmed
- negated

The basic conclusion of the paper is that:

"In spite of the very large number of laboratory and field studies which have been published, there are no confirmed reports of harmful biological effects at field strengths anticipated in modern transmission line design and operation."

Author (date): Miller, M.W., Kaufman, G.E., (1978).

Title: High Voltage Overhead

Publisher: Environment Magazine, Vol. 20, No. 1.

Subject: Electrostatic and Electro-magnetic Effects

pp.: 6-36

Summary: Miller and Kaufman conclude that neither animal and plant experimentation nor clinical studies nor 25 years experience with operating EHV transmission lines have to date provided convincing evidence for a harmful effect of exposure to electric and magnetic fields associated with transmission lines, in spite of numerous attempts to find such effects. Likewise, on a biophysical basis one would have no reason to expect there to be effects. Thus, while one can never prove the negative (i.e., that there is no effect), the overwhelming body of scientific evidence indicates that electric and magnetic fields associated with high voltage transmission lines have no deleterious biological effects.

Current plans for future higher voltage transmission lines appear to limit maximum ground level electric fields to approximately the 10 kV/m level. Miller and Kaufman believe this is prudent. Above about 10-12 kV/m the possibility of "annoyance" shocks becomes greater and in a "worst case" situation a dangerous "no-let-go" incident of a child holding onto a large vehicle could be imagined. Also, above 15 kV/m some people may find the skin sensation annoying. Therefore, while there does not appear to be any serious risk from the direct biological effects of electric or magnetic fields generated by future transmission lines operating at higher voltages, if future designs call for gradients much in excess of 10 kV/m we would suggest that a serious risk-benefit assesssment should be undertaken.

Author(Date): Lee, J.M. Jr., Bracken, T.D., Capon, A.S., Sarknen, S.H., Ihle, G.M., Perry, D.E., Eyler, T.R. (June, 1977).

Title: Electrical and Biological Effects of Transmission Lines - A Review.

Publisher: Bonneville Power Administration U.S. Department of Energy.

Subject: Review of Electrical Effects of Literature pp. 75.

Summary: The booklet was prepared by an interdisciplinary Biological Studies Task Team set up by the Bonneville Power Administration to review information continually being developed on the biological effects of transmission lines. Specifically, the booklet describes the electrical effects of transmission lines and the effects that such lines may have on man and his environment. Some of the methods used by BPA to reduce or eliminate undesirable biological effects are also discussed. The booklet is oriented at Bonneville's construction standards. Basic conclusion is that present standards are adequate.

Author(Date): Morris, R.M. (1976)

Title: Effects and High Voltage Hazards of Power Lines.

Publisher: Canadian Committee on Agricultural Engineering

Subject: Electrostatic and Electro Magnetic Effects.

Summary: Summarizes existing scientific data on the following electrostatic and electomagnetic phenomena including:

- Corona Effects
    - Radio Noise
    - Audible Noise
    - Ozone Generation
    - Television Interference

- Electromagnetic Radiation
- Flashover
- Electrostatic Shocks
- Magnetic Fields
- Subtle Phenomena

Author(Date): Rural Electrification Administration - United States Department of Agriculture (1976).

Title: Electrostatic and Electromagnetic Effects of Overhead Transmission Lines

Publisher: Rural Electrification Administration - U.S. Dept. of Agriculture

Subject: Electrostatic and Electromagnetic Effects.

Summary: As transmission line voltages and currents increase, possible problems associated with electrostatic (E/S) and electromagnetic (E/M) coupling between overhead alternating current transmission lines and conductive objects increase. Electrostatically-induced voltages are possible when a conductive object insulated from ground is in the vicinity of over-head lines. Similarly, electromagnetic induction effects are possible when transmission line phase conductors carrying fault currents cause induced voltages at the open ends of an insufficiently grounded conductive object.

If the conductive object is not adequately grounded when a person or animal comes in contact with it, a current flows in the connection to ground through the electrical body resistance. Object ground intervals that will reduce the E/S and E/M induction effects are based on the maximum allowable shock current passing through a person or animal when touching the conductive object. For the E/S case, a steady state shock current magnitude of five milliamperes is being considered as the maximum "let'go"* level in the proposed revision of Part 2 of the National Electrical Safety Code. Other practical considerations may dictate that the shock current magnitude be kept below the one milliampere "threshold of perception" level. For the E/M case, recommended object grounding intervals are based on a 50 kilogram (110 pound) person experiencing no more than a 0.5 percent probability of "ventricular fibrillation". Detailed analytical methods in Chapters II, III and IV are employed in determining the effects of E/S and E/M induction on conductive objects. Field test data of several investigators are also included to verify the theoretical calculations. The following grounding tables are of interest to farmers:

---

* The let'go level is a threshold where a person can no longer voluntarily break contact with an electric current.

Non-Electric Fence Grounding Intervals for Line Voltages 345 Kv and above (E/S Case)

Line Voltage (kV)	Fence Lateral Distance From Centre of Row (Feet)	Fence Grounding Interval for I_{SHOCK} = 1 $_{M}$A* (Feet)	Fence Grounding Interval for I_{SHOCK} = 5 $_{M}$A** (Feet)
345	Within 75	200	1,000
500	Within 125	150	750
500	Between 125 and 250 (Min.)	200	1,000
765	Within 175	125	625
765	Between 175 and 375 (Min.)	200	1,000

* = Perception Threshold Current Level Flowing Through a Person

**= Let-go Threshold Current Level Flowing Through a Person

Source: Rural Electrification Administration (1976)

Metallic Object Grounding Criteria for Line Voltages 345 kV and above (E/S Case)

Line Voltage (kV)	Object Horizontal Distance from Outside Phase Conductor (Feet)	Minimum Area of Metallic Surface Requiring Grounding (Square feet)	Minimum Length of Gutter Requiring Grounding (Feet)
345	Within 75	*	*
345	Between 75 and 100 (Min.)	2,000	150
500	Within 100	*	*
500	Between 100 and 150 (Min.)	2,000	150
765	Within 130	*	*
765	Between 130 and 215 (Min.)	2,000	150

* = No minimums are specified. Consideration should be given to grounding of any insulated metallic object.

Source: Rural Electrification Administration (1976)

Appendix 4b

Socio-Economic Effects

Appendix 4b Socio-Economic Effects

Author(Date): Bomford, P.H. (1974)

Title: A Study of the Projected Effect of Hydro Towers on the Revenues of Farmers in the Ridgetown Area.

Publisher: Ridgetown College of Agricultural Technology.

Subject: Land loss, time loss and weed control problems around transmission towers in Southern Ontario.

pp.: 33

Summary: Fifty tower sites were surveyed on two transmission lines in Ridgetown, Ontario. All towers were 26 feet square. Non-cropped area and crop damage was measured. The following is the Summary of Findings from the Study.

1. Towers oriented at 45° to the direction of cropping resulted in more wasted time and more lost area than did similarly-sized towers oriented parallel/perpendicular to the directin of cropping. (P14).

2. The best location for a tower in terms of wasted time, lost area and minimum contact with equipment is straddling the fence row. Other locations (in descending order) are - along-side the fence row, just clear of the headland, in mid-field, within the headland. (P 28)

3. 1 to 1 1/2 feet was considered to be a satisfactory clearance between the footings of a tower and typical farm equipment in the area. (P25)

4. The effect of multiple tower lines was found to be linearly related to single tower lines in terms of wasted time and lost area. Operator stress was noted under these circumstances. (P 30)

5. The major financial effect of a tower is the loss of crop on the area occupied by the tower. For example, for a 28 x 28 foot "Square" tower in grain corn, the total cost was computed as \$25.12, which breaks down to \$4.59 for wasted time, \$17.96 for lost crop and \$2.57 for damage to the growing crop by row-crop operations around the tower. Each of these factors is greater in the case of a "Diamond" tower. (P 14)

6. Weed control recommendations are included in the report. Typical weed control costs would be \$5. - \$8. per tower per year. (P 20)

7. A limited test to study the effect of equipment size on time wasted and area lost indicated that these items would not increase greatly if the trend towards larger equipment size continues. (P 23)

Author(Date): Boyer, Jeannette C., Mitchell, Brace, Fenton, Shirley, of the University of Waterloo. April, (1978).

Title: The Socio-Economic Impacts of Electric Transmission Corridors - A Comparative Analysis.

Publisher: Royal Commission on Electric Power Planning, Province of Ontario.

Printer: Province of Ontario.

Subject: Socio-Economic Impact Study.

pp.: 159

Summary: 1. The purpose of the study was to examine the long-term social and economic impacts of a 500 kV and a 230 kV transmission line. The lines studied were the 500 kV line between Essa and Kleinburg and the 230 kV line between Essa and Orangeville. The lines are of different age, voltage and physical size. An attempt was made to identify the influences of these factors on social and economic impacts. Control lines were identified one mile to the east of the existing line (Chapter 1).

2. A review of the literature dealing with the social and economic impacts of transmission lines was undertaken. The review includes a number of studies done for utility companies throughout North America (Chapter 2).

3. The physical characteristics of the lines and controls were analyzed. Comparisons were made between each line and its respective control and between the study area. No significant differences were found between the lines and their respective controls but some differences between the study areas were noted (Chapter 3).

4. A total of 1,007 sales of properties on both lines and controls during the years 1967-77 were analysed. Data from Regional Registry Offices was used to examine patterns of frequency of sales and average price per acre for different sizes and types of property. During the 1967-77 period, fewer properties of less than 10 acres and more properties of 10-50 acres were sold on the lines than on the controls. Properties over 150 acres sold with similar frequency. The 500 Kv line showed an increase in sales during the period of land acquisition for the corridor right-of-way but otherwise the frequency of sales on both lines and controls

fluctuated in similar patterns with the general activity of the real estate market. Properties on the lines have consistently lower average prices per acre than properties on the control. Prices were lower by 16-29% with the largest depreciating effect on small properties and a decreasing effect for larger properties (Chapter 4).

5. A total of 108 individuals on both lines and controls participated in a questionnaire survey. Participants were asked a number of factual and descriptive questions and were asked about their perceptions, attitudes and opinion regarding transmission corridors and their impacts (Chapter 5). 54% of those polled felt their farm efficiency was reduced by the presence of transmission lines, 38% felt it was not.

6. Factual and descriptive information was used to construct a community profile of the respondents (Chapter 6).

Author(Date): Fortine, Jean-Marie (1980)

Title: Time and Land Lost with Electric Towers

Publisher: Agricultural Engineering Department, Laval University. Presented at the 60th Annual AIC Conference, Edmonton, Alberta, August, 1980.

Subject: Time and Land Lost with Electric Towers.

Summary: Three methods of estimating land loss and time loss for 120, 230 and 735 kV lines were compared: computer simulation, field trials and farmer survey. The range for each of these methods covered a factor of 10. The mean values for different methods of estimation were close. The following table gives the comparison estimates for land and time loss.

LAND AND TIME LOST VERSUS TOWER TYPES

(5 locations, 25 operations, 53 machines, 32 agricultural productions)

TOWERS	Land Lost (metre^2)		Time Lost (min.)	
	RANGE	MEAN	RANGE	MEAN
WOOD FRAME	5 to 324	68 (1)		
	5 to 370	24.2 (2)		
120 kV	2.4 to 2511	70 (3)	0 to 3.75	0.52
		14.2 (4)		
LATTICE	57 to 472	158 (1)		
(7.62m X 7.62m)	58 to 343	126 (2)		
230 kV	7.2 to 700.9	189 (3)	0 to 14.90	1.17
		175 (4)		
LATTICE	92 to 918	278 (1)		
(12.2m X 12.2m)	107 to 688	273 (2)	0.07 to 24.82	1.98
735kV		288 (4)		
FOUR-GUYS	54 to 775	213 (1)		
735 kV	60 to 496	189 (2)	0.12 to 17.7	2.66

(1) Computer
(2) Field Trials
(3) Gustafson (10)
(4) Survey

Author(Date): Genge, R.A., P.Eng. (1977), Horticultural Research Institute of Ontario

Title: The Economic Effects of Hydro Transmission Towers on Orchard and Vineyard Operations in the Niagara Peninsula.

Publisher: Ontario Hydro

Subject: Economic Effects of Transmission Towers on Vineyards or Orchards.

pp.: 100

Summary: A study funded by Ontario Hydro was conducted at the Horticultural Research Institute of Ontario to determine the effects of Hydro Towers on fruit farming operations in the Niagara Peninsula. In addition to a field survey of existing towers (6.25 m square base) a simulation study of 8.53 m square base towers was conducted for peaches and grapes. A lightweight tower base was situated in different orientations and used to determine lost machine and operator time, lost crop and non-workable area requiring herbicide. These losses were costed using industry averages and totaled to compute the annual cost of the tower to a grower. For peaches this ranged from \$92.24/tower/year to \$137.43/tower/year for in-field locations where no trees were grown under the tower. Peach cultivation under towers was possible for 8.53 m square base towers and reduced the loss to a range of \$30.91/tower/year to \$75.77/tower/year. Most of this loss consisted of crop loss ranging up to 93% of the total. Grapes could not be grown under the tower due to the size of mechanical harvesters in use and losses ranged from \$100.99/tower/year to \$119.73/tower/year for in-field locations. Cost of lost machine time for grapes ranged up to \$17.78/tower/year. Towers at the end of rows cost growers less than in-field locations only in the case of not growing the crop under the tower. Existing towers were estimated to cost \$59.22/tower/year in peaches, \$69.69/tower/year in grapes and \$87.54/tower/year in strawberries. In some cases (peaches, strawberries) the larger tower lowered costs by permitting crops to be grown under the tower.

Author(Date): Gustafson, R.J., Erdman, V.R., Morey, R.V. and Meyer, M.P. (1978).

Title: An Investigation of Electric Power Transmission and Agricultural Compatibility in the MAPP Region.

Publisher: Agricultural Experimental Station, University of Minnesota, St. Paul, Minnesota.Miscellaneous Publication 1713-1978.

Subject: Agriculture's Compatibility with 160 to 345 kV transmission lines in the Mid western U.S.A. with special emphasis on irrigated areas.

Summary: The generated statistics for interaction areas would not imply that significant amounts of land are being lost from agricultural production on a state or regional basis. However, this does not imply that locating a R-O-W on a parcel of land does not have significant effect on the individual parcel. Therefore, future studies on routing and construction procedures should concentrate on minimizing the effect on individual farm units. Quantification should include effects on the total business of a farm, not just the crop-loss aspect.

The use of sprinkler irrigation is rapidly growing in many areas of the Midwest. The amount of land lost from irrigation due to a transmission line R-0-W varies with R-O-W width, orientation and the type of irrigation system used. The loss in revenue associated with the location of transmission R-O-W on irrigated land is much more significant than that for nonirrigated land. Potentially hazardous situations can be envisioned when an irrigation system is located in close proximity, and in particular parallel to, a high voltage transmission line. Current published guidelines and recommendations are inadequate for use by irrigation equipment personnel or irrigators to establish a basis for adequate clearances and sufficient grounding.

Hypothetical straight line R-0-W's placed on aerial photographs indicate that in most highly productive agricultural areas, a very high percentage, ninety percent or above, of the R-O-W will be in agriculturally productive fields.

Aerial photography of towers of existing lines showed large variation in land lost from production exists within any line segment. For the line segments in this study, average losses per structure varied from 644 ft^2 (0.015 ac) for a 230 kV line using H/K Frame structures to 2,213 ft^2 (0.051 ac) for 230 kV line using Lattice structures.

The area lost from production consistently increased as size of structure increased for H/K Frame structures. However, for Lattice structures, the area lost increased as structure base size increased up to approximately thirty feet in width and then remained relatively constant. This trend is attributed to a higher proportion of the towers of the larger size being farmed through. The proportion of farmers operating through the towers increased as the tower size increased. However, significant differences for the same structure size existed between geographic areas. These differences are likely due to variation in average machine size and dominant crop type between geographic areas.

More information needs to be conveyed to farmers, agricultural equipment manufacturers and sales personnel, and organizations concerned with agricultural safety. For example, machinery companies should be made aware of clearance requirements and encouraged to give appropriate warnings on equipment and in their operator's manuals. Sales personnel, particularly of irrigation equipment, should be alerted to what are unsafe situations.

pp. 287.
Comment: especially good irrigation write-up.

Author(Date): Kornelis, T., Kulp, E.L. (1977)

Title: Farming Around and Under Transmission Lines

Publisher: Bonneville Power Administration

Subject: Transmission Line Impacts on Aerial Crop Dusting and Crop Yield trial under transmission lines.

pp.: 100

Summary:

AERIAL CROP DUSTING

BPA employees contacted 30 aerial crop dusting companies in central Washington during March and April 1976. Farms in the area vary from dry land wheat to such irrigated row crops as potatoes, beets and corn. The following information was obtained:

Twenty-eight out of 30 companies interviewed said they routinely fly under transmission and utility lines having a ground clearance in excess of 30 feet. Minimum ground clearances of the various BPA transmission lines are: (1) 115-kV steel or wood construction - 25 feet; (2) 230-kV steel or wood construction - 30 feet; (3) 345 kV steel construction - 32 feet; (4) 500 kV steel construction 35 feet. All pilots interviewed said they make no extra charge for spraying fields that have obstructions such as transmission lines, hedges, and homesites present.

Transmission towers present more of a problem than the conductors. When a tower is in the flight path, the pilot must swing around it. This leaves a wedge-shaped, untreated area in front of and behind the tower. These areas must then be "cleaned up" after the field has been sprayed.

When multiple sets of transmission towers are present, areas between the tower sites may be beyond the reach of aerial sprayers. This situation is aggravated when the towers are staggered but still spaced too close for the pilot to fly between them. This problem can be alleviated by placing the towers in a straight line, preferably parallel with the logical flight path.

CROP YIELD TRIALS

Tower bases for the usual steel tower used by BPA will vary from 18' x 18' to 45' x 45'. The average structure would be less than 25' x 25'. Most farmers cultivate to within a few feet of the footings. A square 35' x 35' equaling 0.03 of an acre is taken out of production, for few farmers farm under towers. Using the agronomist's figures for each crop, an estimate of loss in production would show as follows:

Figures are based on 2 farms for wheat and one farmed for both beets and corn.

Wheat:

Loss under structure - 100% = 0.03 acre
Loss adjacent to structure
100' x 100' = 0.23 acre @ 10% = 0.023 acre
Loss to wheat production = 0.053 acre

Average of 5 structures per mile would mean a loss of 0.265 acre per mile of line.

Potatoes:

Data incomplete.

Sugar Beets

Loss under structure - 100% = 0.03 acre
Loss adjacent to structure
0.1 acre @ 14% = 0.014 acre
Loss to sugar beet production = 0.044 acre

Average of 5 structures per mile wouold mean a loss of 0.22 acre per mile of line.

Sweet Corn:

Loss under structure - 100% = 0.03 acre
Loss adjacent to structure
0.1 acre @ 20% = 0.02 acre
Loss to sweet corn production = 0.05 acre

Average of 5 structures per mile would mean a loss of 0.25 acre per mile of line.

Author: Louise B. Young (1973).

Title: Power Over People*.

Publisher: Oxford University Press, New York.

Subject: A general review of the growth of the extra high voltage transmission systems and the potential dangers this system poses to those that live or work near transmission lines.

pp: 234

Summary: The book is an unlikely combination of a sensational "call to arms" against large power companies in general and high voltage transmission lines in particular and a factual review of the hazards attributed to high voltage transmission lines.

Rather than describing and analysing risks individually, actual case histories are reviewed.

The book also contains an excellent bibliography.

*This book has had a great effect on the way transmission lines are viewed by the public.

Author: McKinnon, Allen and Associates (Western) Ltd. (1978)

Title: The Cost of Farming Around Transmission Line Towers in Central Alberta

Publisher: Calgary Power Ltd.

Subject: Cost of Farming around transmission towers.

Summary: The purpose of the study is to determine economic effects of towers on yields of crops, equipment efficiency, chemical efficiency, risk and management. The study methods included farm surveys, farm operator interviews, aerial surveys, video taping of farm equipment operations around towers, in-the-field measurements, and analysis of crop yield variance around towers. The study area included Calgary north to Benalto along a twin line and Calgary north to Red Deer along a single line. Twenty-five farm operations were chosen for surveys and interviews.

From the interviews the following came to light:

Farmers who had machinery collide with towers	33%
Average down-time per collision	2.6hr
Farmers who thought yields around towers were reduced	87%
Farmers who thought weeds were a problem in and around towers	70%
Average number of machine operations each year	
- on cultivated cropland	10.74
- on summerfallow	5.6
- on hayfields	4.98

Average revenue per arable acre in the study area is $99.85

From machinery observations and measurements, there are two main methods of pulling implements around a tower. The "complex" method means driving to either side of the tower leaving a diamond area not worked. The extra time and cost involved for equipment for the "complex" and "diamond" methods are shown in the following tabulation.

COST PER TOWER PER YEAR TO FARM AROUND SINGLE AND DOUBLE TOWERS AS PRESENTLY PLACED

	Single Tower		Double Tower	
	"Complex" Method	"Diamond" Method	"Complex" Method	"Diamond" Method
Weed control	$11.00	$11.00	$11.00	$11.00
Herbicide misses	.29	.29	.61	.61
Harvesting loss	.34	.34	.34	.34
Double seeding effect	.81	.21	.81	.32
Extra machine operation	3.47	2.86	3.47	2.86
Area lost to production	1.90	2.57	1.90	2.57
Risk of Bertha Army Worm	.72	.72	.76	.76
Time loss due to collision	9.87	9.87	9.87	9.87
Collision repair insurance	4.98	4.98	4.98	4.98
Annual cost	$33.38	$32.95	$33.74	$33.31

The twin line increased the cost slightly per tower.

The farmers interviewed were not united in their opinion, but in the case of a twin line, most preferred the towers opposite each other as opposed to staggered.

There are other operating situations around towers which are variable in nature and occur less frequently. Allowances for the costs of these situations have not been included in the above tabulation. For example, in one case where the tower was too close to the fence to get equipment through, the extra cost was $1.45 per tower for lost crop due to missed areas of herbicide.

Towers would be less of a problem if placed on a fence line. The cost in this situation is estimated to be as follows:

COST PER TOWER PER YEAR TO FARM AROUND TOWERS STRADDLING FENCE LINES

Extra machinery operation	$ 2.24*
Double seeding	.32
Weed control	11.00
Herbicide miss	--
Area lost to production	2.06
Harvesting loss	--
Time loss due to collision	8.00*
Insurance for collision repairs	4.98*
Bertha Army Worm control	.68
	$29.28

* Swathing the outside round backwards with a self-propelled swather and combining the round backwards would substantially decrease the extra machine time required and also reduce the risk of collision.

Appendix 4c

Land Value Effects

Appendis 4c Land Value Effects

Author: Delotte, Haskins and Sells Associates (1980).

Title: The Effect of Pipeline Installations on Agricultural Land Values in Alberta.

Publisher: Delotte, Haskins and Sells Associates.

Subject: A Study of the Effects of Pipeline Installations on Agricultural Land Values in Alberta.

pp: 59

Summary: The study was conceived and completed to determine "The Effect of Pipeline Installations on Agricultural Land Values in Alberta". The objectives of the study were:

- to determine what effect, if any, a pipeline has on the market value of agricultural property,
- to identify related factors which may influence a potential change in agricultural land values, and
- to determine study areas which may have different land value changes due to pipelines.

Study findings indicate that pipelines have no effect on agricultural land values. That is, the presence of a pipeline on a parcel of land does not cause market participants to devalue or discount the total land value. For all seven study regions and in all study cases but one, no significant differences (at the 95% confidence level) were found in the average price per acre between lands with and without pipelines. This finding was consistent for both soil classes and for both sizes of land parcels studied (quarters and greater than 170 acres).

In this study, relaxing the confidence level to 80 or 90 percent would have minimal effect on the results or the conclusions that pipelines have no effect on the market value of agricultural lands.

Author: J.E. Partaker (April, 1982)

Title: Easement Compensation for Transmission Line Rights-of-Way.

Publisher: Right-of-Way, (Magazine)

Subject: Assessment of the costs to the owner of a 500 kV transmission line through land normally used to grow wheat.

pp: 3

Summary: The paper analyses the rationale for determining compensation on a 15 acre strip of right-of-way used for grain production for a 0.5 mile, 500 kV transmission line with tower bases of 878 square feet. The following are estimates of the tangible costs to the farmer per tower structure per year:

rental value 0.03 acres not cultivated	$ 0.90
loss of income from 0.03 acres	4.33
saved expenses 0.03 acres	-2.80
increased work around towers 4 min./operation x 8 x $85./hr.	34.00
value of reduced productivity in area surrounding tower - 80% of yield on 0.39 acres @$85./hr.	45.00
increased material appplication around structures 40% of normal $47/ac. on 0.39 acres	7.30
TOTAL	88.78
one time payment for 2 towers or 16% of market value of the 15 acres.	$ 1,775.60

Manitoba Hydro's policy of compensation for the granting of transmission easements is 75% of market value. About 16% of this is for tangible impacts and the rest is for intangibles. Higher compensation, $115. of market value is given for station sites.

Appendix 4d

Publication Information Booklets

Appendix 4d Public Information Booklets

Author: B.C. Hydro (1978)

Title: Play it Safe - Precautions to take near high voltage power lines.

Publisher: B.C. Hydro

Subject: Public information booklet

pp: 16

Summary: Booklet describes power transmission.

The booklet outlines B.C, Hydro basic policies for shared use of the right-of-way and reviews the following type of effect the transmission lines have:

- Electrical induction on metal building, fences, electric fences
- Irrigation system (wheel and hand move)
- Vehicles
- Fueling vehicles
- Radio and television interference
- Clotheslines
- Kites and model airplanes
- Parachuting, hang gliding
- Hunting

The booklet does not give details such as clearance distances or phone numbers.

Author: B.C. Hydro, No date.

Title: Simply Shocking

Publisher: B.C. Hydro

Subject: Preventing and treatment of electric shocks.

pp: 20

Summary: Pamphlet describes the effects of electric shocks on the human body and the basics of first aid treatment to shock victims. Most of the booklet is devoted to describing hazards and safe procedures to avoid shocks in these situations.

Author: Bonneville Power Administration (1981)

Title: Living and Working Around High-voltage Power Lines.

Publisher: Bonneville Power Administration

Subject: Public Information Booklet

pp: 9

Summary: The booklet describes the types of transmission line and the standards that govern them in the U.S.A. The following types of effects are described along with safe operating procedures:

- safe clearance distances (vehicles should be less than 14 feet in height)
- induced voltages
- irrigation systems (more detail is given in this section than in similar publications by other operators)
- fences
- electric fences
- buildings
- vehicles
- lightning
- fires
- kites and model airplanes
- shooting
- trees
- pacemakers
- explosives

Author(Date): Nichols, D.J. (1978)

Title: Guideline for the Installation and Operation of Irrigation Systems near High Voltage Transmission Lines.

Publisher: Bonneville Power Administration, Seattle, Washington.

pp.: 12

Summary: Information report that covers the following irrigation system types:

- Fixed Type
  - pipe, row and rill
- Mobile systems
  - pipe
  - wheel
  - circular (pivot)
- High volume, high velocity (giant gun)

Report gives installation suggestions and safe working practice for each of the above systems near high voltage lines including 285, 345, and 500 kV AC lines and 400 and 500 kV DC lines.

Author: Ontario Hydro (No date)

Title: Working under Extra High Voltage Lines

Publisher: Ontario Hydro

Subject: Public Information Booklet

pp: 16

Summary: Designed for people who work near 500 kV lines, the pamphlet covers the following:

electrostatic charges (shocks)
charges on vehicles
clearances (20 feet from line under 129 feet tall)
refuelling
building
wire fences
electric fences
irrigation systems
fires
lightning
ozone
television and radio reception
electromagnetic fields
noise
explosions and the Esso Demonstration centre

Author: Westcoast Transmission Company, (1982).

Title: Westcoast Pipeline Minder (annual edition)

Publisher: Westcoast Transmission Company Ltd.

Subject: Datebook and Public Information Booklet

pp: 20

Summary: A little pocket diary and notebook is given to all owners of Westcoast Rights-of-Way each year. It includes safety information, a pipeline system map and phone numbers of all local offices.

Appendix 4e

Other Studies

Appendix 4e Other Studies

Author: Canadian Electric Association (1981)

Title: Canadian Electric Association Guidelines for Electric Transmission Line Development

Publisher: Canadian Electric Association

Subject: Environmental Procedures Guidelines for high voltage transmission lines.

Summary: Guidelines for environmental procedures are given in a non-detailed, general manner. Subjects covered are:

Planning
Multiple use Rights-of-Way
Overhead and underground lines
Scheduling of construction
Route Selection
Data Gathering and Analysis
Design
Clearing
Construction
Operation and Maintenance

Author: Grumstrup, P.D., M.P. Meyer, R.J. Gustafson, E.R. Hendrickson. (1982).

Title: Aerial Photographic Assessment of Transmissin Line Structure Impact on Agricultural Crop Production.

Subject: The use of low altitude 35mm vertical aerial photography as a method to determine crop type, crop pattern, orientation of towers, land loss to production and structure dimension, location and type.

pp: 5

Summary: Vertical 35mm true color negative type aerial photography provided an acceptable data base for describing electrical transmission line structure impact upon agricultural land in the Midwest. Information provided included crop type, cropping patterns, orientation of structure to cropping patterns, production area loss, and structure dimensions and characteristics. A 1:5,000 nominal film scale exposure was obtained of each of 2,668 structures on 17 pre-selected transmission line segments in six states by means of a floor-mounted 35mm motordrive camera in a small aircraft. Each negative was production-enlarged to a 8.9 by 12.7 cm (3 1/2 by 5 in.) print and analyzed with a pocket comparator with measuring reticle and a special area grid.

From this the following was determined at a cost of less than $2.00 per tower (see Gustafson et al, 1978).

- As the structure size increased, the land lost also increased with H/K frame type structures;
- For Lattice structures, the land lost reached a peak for a tower of 25 to 29 feet in width and then decreased slightly due to farmers being able to pass through with their equipment:
- Comparison of results for modified H/K frames and tangent H/K frame structures confirms that guy wire presence significantly increases land lost to production; and
- In many cases, structure presence had considerable influence upon row crop field operating patterns.

Author(date): Ian Hayward and Associates. (1982)

Title: Common Utility Corridor Study

Publisher: Ian Hayward and Associates for the B.C. Utilities Commission

Subject: Common Utilities Corridors in B.C.

pp.: 43

Summary: Common corridors are measures which reduce the amount of land used and the environmental impact of linear developments. In B.C., this is usually achieved at extra cost, except in suburban areas where land values dominate route selection.

The topographical and geotechnical features existing in B.C. have resulted in a minimum number of shared rights-of-way. In the main, these consist of rights-of-way with similar linear development, e.g., pipelines. No example of a common corridor of significant length containing different users was discovered in B.C. during the course of the study.

In other parts of this continent it appears that common corridors are more common in suburban areas and where there is established ownership of the corridor. They are most readily implemented when all linear developments have a common source and similar direction and occur coincidentally. Sometimes an existing linear development forms "the spine" of the common corridor, and that agency acts as a co-ordinating body.

In B.C., most of the major valleys contain a linear development or a corridor. In general, the challenge presented is to recognize the need for future linear developments, to assess the capability of existing corridors to accommodate additions, to select the appropriate one or to plan a new corridor. In particular, there is a need to create corridors into the major cities. These should be common corridors, which means that land must be acquired, funding provided and a form of expropriation devised.

Author: NOVA an Alberta Corporation (1981).

Title: The Alaska Highway Gas Pipeline Project, Saskatchewan Segment
Environmental Plans and Procedures Manual.

Publisher: NOVA an Alberta Corporation.

Subject: Documentation for the Environmental Requirements, Planning and Procedures and Administrative Process for the Saskatchewan Segment of the Alaska Highway Pipeline Project.

pp: 125

Summary: A state of the art documentation including:

Regulatory Requirements, summarizes federal and provincial legislation, regulations and guidelines containing environmental stipulations which are applicable to the design, construction, and operation of a gas pipeline in Saskatchewan. It contains a list of federal and provincial government departments, the legislation administered by them and indicates those departments or agencies from whom approvals are obtained.

Environmental Planning, describes how project-specific environmental concerns are determined and responded to during the design phase. Route location and refinement, one of the most important project planning activities in terms of overall reduction of environmental impact, is described.

Environmental Procedures presented in Section 4.0 are those considerations which are applied to the Project. While the points are presented in the form of construction guidelines, they are equally objectives of the design phase. As typical measures employed during construction they reduce or eliminate the majority of spatial or temporal conflicts between environmental parameters, construction activities and temporary and permanent project facilities.

Section 5.0, Administrative Procedures, outlines the orientation and training program, an environmental quality control program and contingency responses.

Author (Date): Petroleum Industry Training Service (1982)

Title: Environmental Planning for Linear Development.

Publisher: Petroleum Industry Training Service

Subject: Training Seminar Papers

Sumary: Compilation of papers given at the 1982 P.I.T.S. Conference.

Papers Include:

Planning for Utility Corridors and Multiple Facility Rights of Way

Route Selection Methodologies for Linear Development Planning Processes

Environmental Inspection of Construction

Author: Westcoast Transmission Company Limited (1981).

Title: Procedures Manual for Environmental Engineering Revised Oct. 1981.

Publisher: Westcoast Transmission Company Ltd.

Subject: Outlines Construction and environmental mitigation measures used by Westcoast and related companies during pipeline construction.

pp: 53

Summary: An environmental procedures manual that is used as an information document for use by company personnel in designing, instructing and maintaining pipeline systems in B.C. The manual is also used to provide a set of standard methods which is used by consultants and government agencies in reviewing pipeline proposals and monitoring field activities.

The manual describes procedures routinely followed by Westcoast, and summarizes the complex regulatory requirements which apply to gas pipelines systems. Procedures are discussed in the normal sequence of activities, followed by a summary of environmental legislation. These are Planning and Design, Construction, Operation and Maintenance, and Abandonment. The last section describes current environmental legislation.

The manual is a "current state of the art" document and is regularly updated.

Appendix 5a. Contact List

Federal

Federal Environmental Assessment Review Office
Mr. Stephan Fuller

National Energy Board - Environmental Group
Mr. Ted Lawrence - (613) 996-3448

Electrical Power Planning
Mr. N. Caris - 996-3110

Environment Canada, Environment Protection Service
Mr. Adrian Duncan - 666-6711

Lands Directorate
Dr. Doug Lacate - 666-3161

Provincial

Ministry of Energy, Mines & Petroleum Resources
Project Analysis Branch
Mr. Denis O'Gorman, Director - 387-5231
Mr. Jamie Alley
Ms. Judy Wigmore

Ministry of Environment
Terrestrial Studies Branch - 860-73923
Mr. Evert Kenk

Planning and Assessment Branch
Mr. Bryan Gates - 387-4441
Mr. Bob Langford, Coordinator Surveillance and Monitoring

Ministry of Agriculture and Food
Farmland Resources Branch
Mr. Harvey Sasaki

Agricultural Land Commission
Mr. Kabel Atwall
Mr. Jim Plotnikoff

Appendix 5b. Government and Industrial Documents Reviewed.

British Columbia Environment and Land Use Committee Secretariat. 1980. *Environmental and Social Impact Compensation/Mitigation Guidelines*. Working Group on Mitigation and Compensation, Victoria, B.C. July.

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Appendix 6

Study Terms of Reference

SCHEDULE "A" August 4, 1982

TERMS OF REFERENCE
OPPORTUNITIES AND RISKS PRESENTED TO AGRICULTURE BY LINEAR DEVELOPMENTS

INTRODUCTION

As a result of increasing energy demands, an unprecedented number of large scale transmission line and pipeline projects are being proposed for British Columbia in the next twenty years. Improvements to transportation networks, in order to increase travel efficiency, are also being proposed. As a whole, many of these linear developments may result in major impacts and effects on agriculture in the province. While impacts are usually viewed as being negative effects, some of these developments can create opportunities for agricultural expansion.

PURPOSE

To provide an overview of the type, size, length and location of existing and proposed linear developments in the province and the areal extent of their effects on agriculture.

To identify the potential impacts and effects presented to agriculture by linear developments in British Columbia.

To prepare an annotated bibliography on the opportunities and risks presented by linear developments.

To recommend changes in existing policies, guidelines and regulations, which would lead to greater realization of potential opportunities and mitigation of potential risks.

SCOPE

The study will involve the examination of opportunities and risks of linear developments to agriculture, with emphasis being placed on transmission lines and pipelines. Highways and railways will be dealt with in an overview manner. The area to be covered is the Province of British Columbia.

APPROACH

The study will involve three phases:

* Phase 1--Inventory of linear developments.

  A provincial overview of transmission lines (greater than 200 kV) and major pipelines. Information required

  (a) project name, number and owner (i.e. Kelly Lake-Cheekeye-5L41 , BC Hydro)
  (b) project size (i.e. 500 kV)
  (c) overall length
  (d) corridor width
  (e) status (i.e. proposed, expected/scheduled date of construction-existing)

A summary of generalized agricultural areas affected, broken down into cultivated and grazing land for the province. Provide an overview of expected agricultural area affected by potential developments. Identification of major substations and compressor stations (name, size and area of land covered).

Major highway and railway projects result in basically negative effects on agriculture, with opportunities being limited. The information to be presented should be a short written summary on the effects of such projects on agriculture, along with a statement of major proposed projects which could affect lands with agricultural capability.

* Phase 2

Undertake a study of the opportunities and risks to existing and future agricultural developments due to present and proposed linear facilities. Information in this phase will be presented in two parts.

Part 1: Annotated Bibliography

An exhaustive literature search resulting in the preparation of an annotated bibliography on opportunity and risks of linear developments. Where available, the annotation should include abstracts.

Part 2: Case Study

A detailed agricultural assessment of the effects of an existing transmission line and pipeline will be made. The particular projects selected for study should involve the widest range of agricultural interests (i.e. grazing lands, cultivated land, irrigated land, wide range of crops). The choice of project to be studied shall be left to the discretion of the consultant and is subject to the approval of the Project Management Committee prior to the commencement of work. The assessment should:

(a) identify the opportunities presented to agriculture by the two types of linear development;

(b) identify whether or not the opportunities presented in (a) above have been realized and the extent to which they have been realized;

(c) identify the measures necessary to achieve the opportunities;

(d) identify the alternative opportunities that exist;

(e) identify the negative impacts presented to agriculture by the two types of linear developments;

(f) identify methods to either minimize or reverse the potential negative impacts of the transmission lines and pipelines;

(g) identify the general (non-site specific) costs and benefits of developing the opportunities, and/or of minimizing and reversing impacts, as identified above, to include representative values based on the case study selected.

(h) identify the residual impacts that these linear developments have on agriculture;

(i) if the projects selected for case study contain more than one linear development, identify the advantages and disadvantages to agriculture as a result of grouping similar and dissimilar linear projects in a common corridor;

(j) evaluate the effects of developing agricultural opportunities along linear projects on other land uses (i.e. forestry, wildlife, and recreation);

(k) identify monitoring methods which would be necessary to assess the benefits, impacts and adequacy of mitigative measures associated with similar projects.

* Phase 3: Policy Review

This phase will provide an overview of the current regulatory structure and guidelines for such developments and mitigation measures as well as an assessment of the effects of government policies, guidelines and regulations on the realization of the opportunities presented to agriculture by linear developments and on the mitigation of their risks. Recommendations regarding changes required to realize the agricultural opportunities should also be provided in this phase.

DOCUMENTATION

The consultant will provide eight copies of the study in the following manner:

Phase 1:
- a) text summarizing the extent of linear developments in the province and its effect on agriculture;
- b) tabular presentation of information requested on transmission lines, pipelines, substations and compressor stations;
- c) mapping of transmission lines, pipelines, substations and compressor stations on a 1:2,000,000 base depicting A.L.R.'s.

Phase 2:
- a) bibliography to be presented as an annotated bibliography in a standard format;
- b) case study - text outlining the nature, location and type of effect along the transmission line and pipeline;
- c) mapping - to be done at a detailed level (i.e. 1:10,000) identifying locations of opportunities and risks. Aerial photographic documentation of impacts and opportunities realized and/or lost;
- d) comprehensive review of general findings from a) and b) above.

Phase 3: text on information required.

A summary report is to be prepared presenting the basic findings of Phases 1-3 and is to be circulated with both the draft and final reports. The summary report will be prepared in a style suitable for wide distribution.

PROJECT REVIEW

After consultant's completion of each Phase, a technical review by the Project Management Committee shall take place.

TIME FRAME

Phase 1 - one month after commencement of the project (Sept 15). Review of information presented to be completed in a two week period (Sept 30).

Phase 2 - three months after commencement of the project (Nov 15). Review of information presented to be completed in a two week period (Nov 30).

Phase 3 - four months after commencement of the project (Dec 15). At this time, twelve copies of the first draft of the complete study shall be provided to Project Management Committee. A four week period will be allotted for review of each draft report (Jan 15).

Final Report - This project shall be completed in a six month period after the project is approved (Feb 15).

LIAISON AND CO-ORDINATION

A Project Management Committee, chaired by Mr. Harvey Sasaki of the B.C. Ministry of Agriculture and Food, has been established to oversee progress on the project. The Committee includes representatives from the B.C. Minsitry of Agriculture and Food, the B.C. Agricultural Land Commission and the Range Management Branch of the B.C. Ministry of Forests. The consultant will be expected to work closely with this committee, meeting with the committee to discuss progress at the start and end of the study, as well as at the end of each Phase. It is expected that such meetings will be held in the Lower Mainland area. Close contact should be maintained with the committee chairman.

A contract will be established with the A.R.D.A. Branch of the B.C. Ministry of Agriculture and Food. Payments will be made based on monthly invoices, subject to a holdback of 15 percent per payment pending satisfactory completion of the project.

PROJECT MANAGEMENT COMMITTEE

OPPORTUNITIES AND RISKS PRESENTED TO AGRICULTURE BY LINEAR DEVELOPMENTS

(ARDSA PROJECT #271315)

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Farmland Resources Branch
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Kabel Atwall
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Dr. Earl Jenson
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POOR

QUALITY

ORIGINAL